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THE ARCHEGONIUM OF CATHARINEA ANGUSTATA BRID. (ATRICHUM ANGUSTATUM)

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(WITH PLATES I–VIII AND ONE FIGURE)

The archegonium of the Musci has been studied by numerous investigators, but the accounts of the developmental processes, especially the development and growth of the canal row, are so varied and even contradictory that the whole subject is in need of reinvestigation. *Catharinea* has been selected for an initial study because it is a representative of the most advanced group of the Musci. The results of studies of representatives of lower groups will appear later.

Material and methods

Catharinea is quite abundant in the region about Madison. The particular species here studied is *Catharinea angustata* Brid., as identified by Mrs. ELIZABETH G. BRITTON, to whom the author is greatly indebted for this courtesy. This entire investigation has been made on what is probably dioecious material. The sex organs were found not only on different gametophores, but these upright branches occur in relatively large, well defined patches or clusters of one sex or the other. A few cases were found in which the patch contained the upright branches of both sexes mixed together indiscriminately. The evidence here presented, while suggestive, is not conclusive of dioeciousness. An exact determination must await careful experimental work from spore to mature

plants. Abundant monoecious material, identified by Mrs. BRITTON as belonging to the same species, has been found at other stations, but this has been reserved for a later investigation.

Like many of the Musci, *Catharinea* displays evidence of being quite plastic. Thus plants taken from the same patch have shown striking variations in the number of lamellae; and even on different leaves of the same plant the number of lamellae may fluctuate beyond the limits given in taxonomic descriptions. The writer has little sympathy with the present tendency toward the manufacture of endless numbers of species on extremely slender bases. In regard to *Catharinea* careful investigations are needed to determine whether these minor differences are in reality specific, or are merely the fluctuations of a plastic form.

C. angustata forms archegonia rather early in the spring. Frequent collections were made at Eagle Heights, about 4 miles from the city, beginning the first week in April and ending the latter part of May. This was supplemented by other collections from stations on the campus and from Dorwood's Glen. The plants were transferred to large moist glass jars and almost daily killings made, thus securing a wealth of material for study. The killing agents used were 0.25 chrom-acetic and Flemming's medium. For the study of young stages serial paraffin ribbons were cut 5–6 μ; for the older stages 8–12 μ. As stains, safranin in combination with Licht Grün, Flemming's triple, and Heidenhain's iron alum hematoxylin were employed.

In staining moss material 10 μ or more in thickness the difficulty is often experienced that during the process some of the sections are almost certain to wash off, especially in the iron alum hematoxylin combination. This trouble was avoided through the use of a modification of the fixative devised by LAND (**11**). By experimentation the least possible amounts of gum arabic and chromic acid effective in 100 cc. of water were determined. Through the use of this there was no discoloration of the sections and staining was not interfered with. It was also found that standing the slides on end and allowing the excess fixative to drain off aids in preventing discoloration. CHAMBERLAIN (**3**, p. 114) states that this fixative will not keep. The writer, remembering a sug-

gestion once offered by LAND, has, in a well blackened bottle, fixative nearly a year old which is just as efficient as when first made up.

Historical

HOFMEISTER (**6**) in 1851 published the first account of the developmental processes in the archegonia of the Bryophyta. He examined a number of forms both among the Hepaticae and the Musci. In the latter group he found the antheridium and the archegonium exactly alike in the early stages of development, a fact which has been confirmed by subsequent investigations; but his account of the formation of the archegonium proper has received no confirmation from later workers. It is of interest therefore only from a historical standpoint. Among the Musci HOFMEISTER seems to have examined *Sphagnum*, *Phascum*, *Archidium*, *Funaria*, *Fissidens*, *Dicranum*, and *Polytrichum*.

In the early stages the growth is by an apical cell with two cutting faces. In each of the 2 cells thus formed there occurs a radial longitudinal division. The young archegonium now consists of 4 rows of cells. Then the formation of the archegonium proper takes place. In this process the cells of one of these longitudinal rows divide parallel to the outer wall, thus producing a central row of cells (the canal row) surrounded by 4 peripheral cell rows. Later 2 of these peripheral cells divide, thus completing the 6 cells of the periphery of the neck.

In 1858 SCHIMPER (**12**) published his historic monograph on *Sphagnum*. He describes the early stages in archegonial development as arising through the activity of an apical cell with 2 cutting faces, thus confirming the account given by HOFMEISTER. He is unwilling to commit himself in regard to the origin of the archegonium proper, however, referring the reader to HOFMEISTER'S account in the mosses, which he is able neither to affirm nor to deny.

KÜHN'S (**10**) interpretation of the development of *Andreaea* appeared in 1870. His account of the origin of the archegonium proper differs radically from that given by HOFMEISTER. He found that in the uppermost cell, which finally becomes the mother cell of the archegonium proper, 3 walls appear in such a way as to cut

out 3 peripheral segments and originate a central cell. The central cell now divides into an outer and an inner cell. The latter is the first cell of the axial row. The outer cell grows considerably, and again the 3 peripheral segments and the inner cell are cut off. The latter divides into an inner and an outer cell. Thus the second cell of the axial row arises just as did the first, and KÜHN holds that all subsequent cells of the axial row are produced in the same manner.

In 1872 JANCZEWSKI (9) made a study of the archegonia of several mosses. He names 2 species of *Sphagnum*, *Atrichum* (*Catharinea*) *undulatum*, *Bryum crudum*, *Funaria hygrometrica*, and *Phascum cuspidatum*. JANCZEWSKI'S account of the development of these mosses is very brief. He mentions only the chief points, and gives no details. It is unfortunate also that the paper has no illustrations. In regard to *Atrichum undulatum*, *Bryum crudum*, *Funaria hygrometrica*, and *Phascum cuspidatum*, his chief points are as follows: There is development by an apical cell with 2 cutting faces, producing a few-celled structure which at this time cannot be distinguished from a young antheridium. In the uppermost cell, which is to be the mother cell of the archegonium proper, there now appear, just as KÜHN described for *Andreaea*, 3 oblique walls cutting off 3 peripheral segments and forming a funnel-shaped inner cell. This inner cell then divides to form an outer cell (the cover cell) and an inner cell. This last formed inner cell again divides, the lower cell being the ventral cell of the archegonium, while the upper cell is the primary neck canal cell. The cover cell continues to act as an apical cell, cutting off peripheral segments and canal initials. The number of canal initials varies from 2 to 6. The cover cell may cut off 1, 2, or 3 peripheral segments before forming a new canal initial. That is to say, there is no mathematical proportion between the cutting off of peripheral segments and canal initials. In the growth of the canal row the cells are of different origins. The upper cells arise through the cross divisions of the 2–6 canal initials, while the lower cells arise through the transverse divisions of the primary canal initial. The archegonium of *Sphagnum* is reported in general to show the same sort of development that has been described for the other mosses.

In 1884 HY (**8**) summarized the archegonial situation in the Musci as well as in other groups. His paper is noteworthy only for its philosophical considerations. In a very general way he confirms the findings of JANCZEWSKI, but adds little that is new or convincing to the subject.

In 1895 CAMPBELL (**2**, pp. 201, 202) studied the development of the archegonium of *Funaria hygrometrica*. Here the first division separates a basal cell from a terminal cell, which is the mother cell of the archegonium proper. "In the latter 3 walls now arise, as in the Hepaticae and *Andreaea*, but in *Funaria* they do not all reach the basal wall, but intersect at some distance above it, so that they inclose a tetrahedral cell, pointed below instead of truncate." The tetrahedral cell makes the usual division into "cover cell" and inner cell. The latter now divides, forming the primary neck canal cell and the ventral cell. "The cover cell instead of dividing by quadrant walls has a regular series of segments cut off from it and acts as an apical cell. These segments are cut off parallel both to its lateral faces and base and thus form 4 rows of segments, the 3 derived from the lateral faces forming the outer neck cells, and the row of segments cut off from the base constituting the axial row of neck canal cells." As to the further growth of the canal row, CAMPBELL states that the canal cells, "so far as could be determined, do not divide after they are first formed."

GAYET (**4**) in 1897 undertook a re-examination of the whole question of archegonial development in the Bryophyta, the investigation covering numerous forms both among the Hepaticae and the Musci. In the latter group, which alone interests us in the present discussion, he mentions 3 species of *Sphagnum*, 2 of *Andreaea*, and the following members of the Bryales: *Archidium*, *Ephemerum*, *Pleuridium*, *Phascum*, *Diphyscium*, *Barbula*, *Orthotrichum*, *Eucalyptra*, *Bryum*, *Mnium*, *Fissidens*, *Fontinalis*, and *Hypnum*. Summing up the main points of his study GAYET arrives at the following conclusions (p. 241):

1. L'archégone des Hépatiques se développe, non seulment par croissance intercalaire, mais encore par croissance terminale.

2. Chez les Mousses cette croissance terminale contribué fortement a l'allongement de l'organe femelle; il n'y a donc pas seulement 5 ou 6 segments.

3. La cellule terminale ne donne point de cellules de canal, pas plus chez les Mousses que chez les Hépatiques.

4. Les cellules de canal du col ont toutes la même origine; elles proviennent toujours d'une initale détachée de la cellule mère de l'oosphère; il n'y en a point d'adventives qui seraient formées aux dépens de la cellule terminale.

GAYET'S conclusions, therefore, are diametrically opposed to those reached by other investigators.

In 1898 GOEBEL (5) gives a rather brief and unsatisfactory account of his examination of *Mnium undulatum*. He states (p. 17): "I find in this plant confirmation throughout of the statements of JANCZEWSKI and others, and that the archegonium of the Musci is to be distinguished from that of the Hepaticae by its peculiar apical growth" (text fig. 1). The cell represented as apical in this figure is most certainly not the one described by JANCZEWSKI. GOEBEL'S illustration would lead us to believe that the canal row has been formed by the activity alone of the one cell marked +. This is most certainly not the method of canal row formation described by JANCZEWSKI. Hence GOEBEL must be regarded as giving an entirely different account for the development of the canal row.

FIG. 1.—Archegonium of *Mnium undulatum*, reproduced from GOEBEL'S *Organography, fig. 8, iv+*.

HOLFERTY (7) in 1904 made a critical study of the archegonium of *Mnium cuspidatum*. Here for the first time we have evidence somewhat scanty, but thoroughly convincing so far as it goes, because based on the sure foundation of division figures. In the development of the canal row HOLFERTY found once, and figures, the cover cell adding to the canal row. In 3 other archegonia he shows the topmost canal cell in the process of division, while in one case the basal neck canal cell is dividing.

Regarding the development of the archegonium proper his summary is as follows (p. 122):

6. In the young archegonium the 2-sided apical cell gives place to a 3-sided one which is truncate.

7. This terminal cell divides transversely soon after its formation giving rise to the first cell of the axial row.

8. The terminal cell adds to the growth of the neck by segments cut from its 3 lateral faces, and to the growth of the axial row by segments cut from its truncate face.

9. Growth in length of the archegonium neck is intercalary as well as apical in both neck and canal rows.

SERVETTAZ (**13**) in a quite recent physiological paper on the Musci includes an investigation of the development of *Phascum cuspidatum*. The developmental story is given briefly as follows (p. 171):

> La cellule initiale se cloisonne transversalment et donne une cellule de peid, "a," et une cellule supérieure "b"; la cellule "b" se cloisonne ensuite obliquement un certain nombre de fois (2–5) comme s'il s'agissait de constituer un bourgeon végétatif ordinaire, puis l'une des cellules placées au-dessous de la cellule terminale se divise tangentiellement et détermine la formation d'une cellule central "c" qui, par des cloisonnements basipètes, donne une file de 8 cellules qui seront: 1–4, les cellules du canal; 5, la cellule du ventre; 6, l'oosphere. . . .
>
> Quant à la cellule terminale, "s," elle peut continuer à se diviser et elle forme la calotte recouvrant l'extrémité du col.
>
> En definitive, le mode de formation que nous venons de décrire se rapproche de celui que Goebel a décrit pour Mnium undulatum.

The evidence offered in support of this developmental story is certainly too meager and not sufficiently critical to be convincing. Moreover, the origin of the central cell, or first cell of the axial row, by a tangential division of one of the segments below the terminal cell is a revival of the HOFMEISTER conception which numerous subsequent investigations have failed to confirm, both in the Hepaticae and in the Musci. It would be nothing less than remarkable, therefore, to find the origin of the archegonium proper in *Phascum* fundamentally different from that of the other Musci.

In 1915 the author (**1**) published his studies on the archegonium of *Sphagnum subsecundum*. From sections both transverse and longitudinal it was shown that the archegonium proper is initiated in the terminal cell by the appearance of 3 oblique walls, which cut off 3 peripheral segments and produce the axial cell within. This latter cell on division gives rise to the cover cell and the central cell. Clear evidence is presented that the cover cell is relatively inactive, forming no basal segments, while division figures

make it certain that the growth of both canal row and peripheral cells of the neck is intercalary and not apical.

SUMMARY

In regard to the formation of the archegonium proper in the Musci 3 theories have been advanced: (1) the HOFMEISTER conception of the tangential division of one of the 4 original pedicel rows, a theory soon made untenable by the work of later investigators; (2) a recent revival of the HOFMEISTER scheme modified by the tangential division of one segment only, as proposed by SERVETTAZ; (3) the commonly accepted account, confirmed again and again for all the great groups of the Bryophyta, namely, the appearance in the terminal cell of 3 oblique walls forming 3 peripheral segments and an axial cell within.

It cannot be maintained, therefore, that the origin of the archegonium proper is in doubt. The evidence is too overwhelming to admit of any uncertainty on this point. However, the development of the axial row is another matter. Here is a subject involving widely conflicting accounts, some being diametrically opposed. Summarized, these accounts are: (1) the abandoned conception of HOFMEISTER, having only a historic interest; (2) KÜHN's claim for *Andreaea* that all the cells of the axial row are cut from the base of the apical cell; (3) CAMPBELL states for *Funaria* that the axial row is composed of a primary canal cell and segments cut from the base of the apical cell, none of which divide after they are formed, so far as could be determined; (4) GOEBEL holds that in *Mnium undulatum* the topmost neck canal cell (the one just below the cover cell) acts as an apical cell in the production of the canal row; (5) JANCZEWSKI finds that the cells of the axial row are of diverse origins, the upper arising through transverse divisions of the 2–6 initials cut from the base of the apical cell, while the lower are formed by the transverse divisions of the primary canal initial; (6) HOLFERTY has shown that the growth in the canal row of *Mnium cuspidatum* is both apical and intercalary; (7) GAYET concludes that the canal cells among the Musci have all the same origin, that there are no segments cut from the base of the apical cell, but that the whole axial row arises from an

initial produced by the mother cell of the egg; (8) SERVETTAZ states that in *Phascum* the canal row is formed by the basipetal divisions of the central cell; (9) the author has shown by division figures that in *Sphagnum subsecundum* the growth of the canal row is entirely intercalary.

It is evident that the Bryales are in need of a reinvestigation, not a superficial examination of many forms, but a careful intensive study of representative forms showing as far as possible by actual division figures the course of development. It is with such an idea in mind that the present work has been undertaken.

Development of archegonium

The apparently dioecious *Catharinea angustata* here studied produces a fairly large number of archegonia on each gametophore. The count shows variability with an average of about twenty. As previously stated, young archegonia begin their appearance early in April, and by the middle or end of May the majority have reached maturity. The first archegonium arises from the apical cell region, but whether from the apical cell itself or from one of its immediate segments cannot be stated positively at present. The study of the behavior of the apical cell in the production of archegonia and the continued growth of the gametophore, if fertilization does not occur, must be reserved for a later paper. In its early stages the archegonium develops by the usual method of an apical cell with two cutting faces (figs. 1, 3–5, 7–9). In the large amount of material examined only two exceptions to this statement have been found (figs. 2, 6). In both cases the young archegonia were developing in very crowded quarters, being closely surrounded by the stalks of archegonia nearing maturity.

After a variable number of segments, usually 4 or 5, have been produced by the apical cell, and secondary divisions have appeared in each segment except the terminal one, the plane of division changes. In the terminal cell, as so often described both for Hepaticae and Musci, 3 oblique walls cut off peripheral segments and originate the primary axial cell within. In fig. 10 the first oblique wall has been formed; in fig. 11 two of the oblique walls are shown. These oblique walls usually do not intersect, as CAMPBELL reports

for *Funaria*, but extend to the basal walls. The primary axial cell, therefore, has something of the shape of an inverted, truncated pyramid. There now follows the division of the primary axial cell into an outer axial cell, the cover cell, and an inner axial cell, the central cell (figs. 12, 13). Quite soon the central cell divides, the resulting lower cell being the ventral cell, while the upper is the primary neck canal cell (figs. 14, 15). The actual division of the central cell was found twice. The axial row of the young archegonium now consists of the ventral cell; its sister cell, the primary neck canal cell; and a large cover cell (figs. 15–17).

It is interesting to note that in fig. 15 the original division wall between cover cell and central cell appears tilted, due partly to the inequality in the growth of the peripheral segments, and partly to the change in the direction of the axis through the formation of new peripheral segments by the apical cell. While this tilting is not always found, it is of frequent occurrence, as shown to a greater or less extent in figs. 16, 18, 20, and furnishes valuable evidence in separating that portion of the axial row derived from the central cell from the part contributed by the cover.

The cover cell now cuts off peripheral segments (figs. 15–17). No absolute proof can be given as to their exact number, but it seems more than probable from such a series as figs. 15–18 that there are 3 peripheral segments. Then there is added to the canal row an initial cut from the base of the cover cell. The evidence for this statement rests on fig. 18, on several others quite like it, and is corroborated by the figures in the series about it (figs. 16–20). Several similar series could be constructed from the material studied. A long and careful search failed to reveal the actual division figure, but in fig. 18 the size and position of the nuclei and the delicate wall between leave no doubt that the uppermost canal cell has been cut from the base of the cover cell and that the process has just been completed. As illustrated by fig. 19 the axial row now consists of the ventral cell; its sister cell, the primary neck canal cell; an initial cut from the base of the cover cell; and a large cover cell or apical cell.

Up to this point the process of development is clear and definite; but from this point on there is a variability shocking to no

one save an old-fashioned, rigid morphologist. After the first initial has been added to the canal row, the apical cell again begins to cut off peripheral segments (figs. 20, 23), but in the meanwhile the periphery is also growing by intercalary divisions (figs. 19, 20, 22). While these peripheral processes are going on, the cells of the neck canal row are not inactive. The primary neck canal cell may divide first (figs. 20, 21), or the initial cut from the base of the cover cell may make the first division (fig. 22). That there are intercalary divisions in almost any order at this stage of the process may clearly be seen from the series represented by figs. 25–28. The archegonium has now reached the stage when it contains 4 or 5 neck canal cells. At this time the evidence is positive that the cover cell adds a second initial to the row of neck canal cells (figs. 29, 31). Fig. 29 illustrates excellently the intercalary as well as apical growth of the archegonium.

While fig. 31 is of interest in showing the activity of the cover cell in adding an initial to the canal row, it has an additional interest in giving evidence as to the origin of oblique walls in the axial row. The axis of the spindle is tilted and an oblique wall is being formed. In fig. 32 the process has been completed and the result is very evident. There are then two origins for the oblique walls in the canal row. The first we have mentioned in connection with fig. 15. No reliable evidence could be found that these walls might arise in any other way, such, for example, as the intercalary division of a canal cell. As a result of intercalary as well as apical activity the canal row now contains 5–7 canal cells. In the events that follow there is no definite sequence that can be determined. The only positive statement that can be made is that the number of canal cells is increased by intercalary divisions and in practically any order (figs. 33–45).

Just how active the cover cell is at this time cannot be stated, but the numerous figures in the canal row and the periphery of the neck make it evident that intercalary divisions are responsible in a large measure for the growth of the archegonium. In figs. 42, 44, it seems very probable that in each case the topmost canal cell has been cut from the base of the cover cell. No division figure could be obtained, so that a positive assertion cannot be made.

Fig. 48 shows the formation of what is probably in the majority of cases a last initial cut from the base of the cover cell. Abundant evidence has been found that at some time between the 12–16 neck canal cell stage the cover cell changes its manner of division and segments by a wall perpendicular to its base into two more or less equal parts (figs. 50, 51, 54, 56). The division figure was found once and is shown in fig. 56. No evidence could be obtained that the division may occur before the 12 neck canal cell stage; while after the 16 neck canal cell stage practically all covers showed division. Out of the large number of cases studied only two exceptions were found, one a case of 18 neck canal cells, and the other a case of 20 with the cover in each yet undivided. Such a process, then, while occurring within general limits is by no means fixed. Whenever such a division does occur, it signalizes the end of all true apical activity. The segmented cover stands out well defined from the peripheral segments of the neck and its history can be followed for some time with a reasonable degree of accuracy. Thus in figs. 61 and 62 the cover cell has formed 6 segments (3 shown in median longitudinal section) and is literally the cap of the archegonium. In fig. 72*A* we have the cross-section of the cover of an archegonium containing 35 neck canal cells. It shows clearly the primary division wall 1–1; the quadrant walls 2–2; and the subsequent divisions in each quadrant. When the archegonium is fully matured the segments of the cover merge insensibly with those of the neck, hence an exact statement cannot be made as to the final number produced.

The division of the ventral cell into ventral canal cell and egg was found five times, 3 being shown (figs. 47, 50, 53). Here again one finds the same sort of variability noted for the cover cell, but with a slightly greater range. The division may occur as early as the 11 neck canal cell stage (fig. 47), while several cases were found in which there were 17–20 neck canal cells with the venter yet undivided (figs. 58, 60). The ventral canal nucleus formed by this division is quite variable in size. Sometimes it is about the same size as the egg (figs. 56, 61, 68); or it may be noticeably smaller (figs. 54, 59, 62).

As already stated, the cutting off of initials from the base of the cover cell is in the majority of cases brought to a conclusion some-

where between the 12 and 16 neck canal cell stages; but since the undivided cover cell may be found as late as the 20 neck canal cell stage, it is evident that a variable number of initials may be cut from its base. We have given proof that at least 3 initials are produced, but we can make no positive statement as to the maximum number. By making due allowance for the rapid intercalary growth, we should estimate that in the majority of cases the number does not exceed 5 or 6.

Whatever may be the number of initials, the fact remains that both the canal row and the peripheral cells of the neck continue to grow by intercalary divisions. Figs. 45–61 show some of the many divisions found and furnish ample proof for the statement. This continued intercalary growth finally produces an astonishingly large number of neck canal cells. In the material studied the average count is well over 50; frequent examples in the sixties were found; two in the seventies (one with 74 and the other with 76 neck canal cells); and finally one example in which there were 86 neck canal cells with several of the basal neck canal cells just beginning to disintegrate. Not only is the number of neck canal cells large, but the canal row is generally multiple in its upper part (fig. 65). Less often this multiplicity is found through the middle portion of the neck (fig. 66) and in the basal part of the canal row (fig. 68). We have interesting evidence from fig. 64 that this multiple condition may arise by the simultaneous division of the cells concerned.

A study of cross-sections through mature archegonia furnished some interesting facts. A representative series through the terminal portion of the neck is shown in fig. 69*A–F*. The canal row is not merely double in this portion but generally consists of 3 cells and in some cases 4. The peculiar enlargement of the canal at its upper end is well shown by figs. 65, 69. The breaking down of the canal row in all of the cases observed was acropetal, but did not involve the ventral canal cell. This latter cell persists for some time, but its history up to fertilization has not been followed as yet. The venter of the mature archegonium is not uniform in thickness, but shows variations from 2 to 4 cells (fig. 63).

ABNORMALITIES.—In the large amount of material studied there was a striking lack of the so-called abnormalities. Only

two cases were found, one being illustrated in fig. 70. The archegonium here contains 17 neck canal cells, 3 of which are shown, and has 3 cells in the venter. It seems probable that the 2 lower ones were formed by the division of the egg, while the upper is the ventral canal cell which has remained undivided. Fig. 71 is the reconstruction of a very remarkable double archegonium. It may have originated by the fusion of 2 very young archegonia, or by the longitudinal instead of transverse division of the primary axial cell.

Discussion

Catharinea undulata has been studied by JANCZEWSKI only. The present work on the closely related *C. angustata* confirms in general his statements, especially in reference to the origin and development of the canal row. There can be no doubt that the cells of the neck canal row in *C. angustata* are of diverse origins. The lower arise through intercalary divisions of the primary neck canal cell, while the upper are produced by the intercalary divisions of at least 3 initials cut from the base of the cover cell.

Aside from the activity of the cover cell, there is no evidence that any *one* neck canal cell may act as an apical cell in the development of the canal row. On the contrary, the evidence is clear that *any* cell of the neck canal row may divide and in any order. This process is also in general agreement with the findings of HOLFERTY for *Mnium cuspidatum*, where both apical growth and intercalary divisions are reported. If CAMPBELL is correct, *Funaria* shows a striking difference, in that the primary canal cell and the initials cut from the base of the apical cell do not divide after they have been formed; while GOEBEL'S account for *Mnium undulatum* shows still further difference, in that one of the neck canal cells at the apex of the canal row becomes an apical cell and by its activity produces the further growth of the canal row. If these differences are confirmed, we shall have a remarkably interesting series in archegonial development.

The facts in the present paper furnish an emphatic denial of the sweeping generalization of GAYET that among the Musci the cover cell does not give rise to neck canal cells. While the author has shown in a previous paper that in *Sphagnum subsecundum* no

initials are added to the canal row by the cover cell, this investigation makes it certain that in *Catharinea angustata* at least 3 initials are produced. Just what type of development the representatives of other groups of the Bryales will show remains to be seen.

Conclusions

The archegonium of *Catharinea angustata* grows for a time by apical as well as intercalary divisions in both canal row and peripheral cells of the neck. In its later stage the entire growth is intercalary.

The cells of the canal row have a double origin. The lower are formed by the intercalary divisions of the primary neck canal cell, the upper through the intercalary divisions of the 3 or more initials cut from the base of the cover cell.

How general this condition is among the Bryales must await further work.

Summary

1. The archegonia of *Catharinea angustata* begin to develop in April.

2. The first formed archegonium arises from the apical cell region, but whether fron the apical cell itself or from one of its immediate segments must be determined later.

3. In the earlier stages of development the young archegonium is formed by the activity of an apical cell with two cutting faces producing a filament of a few cells.

4. The archegonium proper is initiated by the appearance in the terminal cell of 3 oblique walls cutting off 3 peripheral segments and originating the primary axial cell within, which on division gives rise to the cover cell and the central cell.

5. The central cell on division forms the primary neck canal cell and the ventral cell.

6. The cover cell is active for a time, cutting off peripheral segments for the outer cells of the neck and basal initials for the canal row.

7. The number of basal initials varies, but is at least 3 in *Catharinea undulata*.

8. The cells of the canal row and the peripheral cells of the neck grow by intercalary divisions, and in any order.

9. The major growth of the archegonium is intercalary.

10. The cells of the neck canal row have a double origin. The lower are formed by the intercalary divisions of the primary neck canal cell; the upper through the intercalary divisions of the 3 or more initials cut from the base of the cover cell.

11. The ventral cell divides relatively early into ventral canal cell and egg.

12. The ventral canal cell is variable in size.

13. The mature archegonium has usually more than 50 neck canal cells, and may contain as many as 86.

14. The canal row is generally multiple in its upper part and occasionally throughout.

15. The disintegration of the canal row is acropetal, but does not involve the ventral canal cell.

16. If the number of neck canal cells is an indication of primitiveness, the most advanced group of the mosses has the most primitive archegonium yet described among the Bryophyta.

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EXPLANATION OF PLATES I–VIII

All figures were drawn with the aid of Abbé camera lucida at table level, and, being reduced one-half in reproduction, now show the following magnifications: figs. 1–27, ×870; figs. 28–35, 64–68, ×700; figs. 36–44, 63, 69, 70, 72–74, ×550; figs. 45–62, ×410; fig. 71, ×225. Abbreviations are as follows: *a*, base of older archegonium; *l*, leaf; *p*, paraphysis.

PLATE I

FIG. 1.—First archegonium arising from apical cell region.

FIG. 2.—Young archegonium with abnormal cross walls arising at base of older archegonia.

FIG. 3.—Typical development by apical cell with 2 cutting faces.

FIG. 4.—The same, slightly older.

FIG. 5.—The same, still older.

FIG. 6.—Development by walls which do not quite intersect; bases of older archegonia seen on each side of young archegonium.

FIG. 7.—Typical development, older stage.

FIG. 8.—The same.

FIG. 9.—The same; relation to apical cell well shown.

FIG. 10.—First archegonium arising from apical cell region which has now segmented irregularly; in terminal cell the first of the 3 oblique walls originating the archegonium proper has been formed.

FIG. 11.—In terminal cell the 3 oblique walls have cut off peripheral segments and formed primary axial cell within.

FIG. 12.—Primary axial cell has divided into cover cell and central cell.

FIG. 13.—The same, slightly older.

FIG. 14.—Central cell dividing to form primary neck canal cell and ventral cell.

FIG. 15.—Division of central cell has just been completed; cover cell has formed a peripheral segment on the right.

PLATE II

FIG. 16.—Primary neck canal and primary ventral cell.

FIG. 17.—The same; cover cell has formed 3 peripheral segments, 2 being shown.

FIG. 18.—Two neck canal cells and ventral cell; topmost neck canal cell is the first initial cut from base of cover cell and has just been formed.

FIG. 19.—Two neck canal cells and ventral cell, later stage.

FIG. 20.—Two neck canal cells and ventral cell; cover cell forming a peripheral segment, while primary neck canal cell is in division.

FIG. 21.—Two neck canal cells and ventral cell; primary neck canal cell in division.

FIG. 22.—Two neck canal cells and ventral cell; first initial cut from base of cover in division.

FIG. 23.—Two neck canal cells and ventral cell; cover cell forming a peripheral segment.

FIG. 24.—Three neck canal cells and ventral cell.

FIG. 25.—Three neck canal cells and ventral cell; middle neck canal cell in division.

FIG. 26.—Three neck canal cells and ventral cell; topmost neck canal cell in division.

FIG. 27.—Four neck canal cells and ventral cell.

PLATE III

FIG. 28.—Four neck canal cells and ventral cell; second neck canal cell from ventral cell in division.

FIG. 29.—Four neck canal cells and ventral cell; simultaneous division of basal and topmost neck canal cell, while cover cell adds a second initial to canal row.

FIG. 30.—Four neck canal cells and ventral cell; cover cell forming peripheral segment.

FIG. 31.—Four neck canal cells and ventral cell; cover cell adding second initial to canal row.

FIG. 32.—Five neck canal cells and ventral cell; topmost neck canal cell cut from base of cover cell.

FIG. 33.—Five neck canal cells and ventral cell; second neck canal cell from ventral cell in division.

FIG. 34.—Five neck canal cells and ventral cell; topmost neck canal cell in division.

FIG. 35.—Five neck canal cells and ventral cell; basal neck canal cell in division.

PLATE IV

FIG. 36.—Six neck canal cells and ventral cell.

FIG. 37.—Six neck canal cells and ventral cell; topmost neck canal cell in division.

FIG. 38.—Seven neck canal cells and ventral cell; second neck canal cell from ventral cell in division.

FIG. 39.—Seven neck canal cells and ventral cell; fifth neck canal cell from ventral cell in division.

FIG. 40.—Eight neck canal cells and ventral cell; fourth and fifth neck canal cells from ventral cell in simultaneous division; topmost neck canal cell probably cut from cover cell.

FIG. 41.—Eight neck canal cells and ventral cell; basal canal cell in division; marked intercalary growth in the peripheral cells of the neck.

FIG. 42.—Nine neck canal cells and ventral cell; middle neck canal cell in division; topmost neck canal cell probably cut from base of cover cell.

FIG. 43.—Nine neck canal cells and ventral cell; fourth neck canal cell in division.

FIG. 44.—Nine neck canal cells and ventral cell; fourth and sixth neck canal cells from ventral cell in simultaneous division.

PLATE V

FIG. 45.—Ten neck canal cells and ventral cell; ninth neck canal cell in division.

FIG. 46.—Eleven neck canal cells and ventral cell; ninth and tenth neck canal cells in simultaneous division.

FIG. 47.—Eleven neck canal cells with ventral cell in division to form ventral canal cell and egg.

FIG. 48.—Eleven neck canal cells and ventral cell; cover cell adding an initial to canal row.

FIG. 49.—Eleven neck canal cells and ventral cell; second neck canal cell from ventral cell in division.

FIG. 50.—Twelve neck canal cells with ventral cell in division; cover cell has divided into 2 almost equal segments; apical activity ended.

FIG. 51.—Twelve neck canal cells, ventral canal cell, and egg; cover cell divided; apical activity ended.

FIG. 52.—Thirteen neck canal cells and ventral cell; ninth neck canal cell in division.

FIG. 53.—Thirteen neck canal cells with ventral cell in division; seventh, ninth, and tenth neck canal cells in division.

FIG. 54.—Thirteen neck canal cells, ventral canal cell and egg; eighth neck canal cell in division; cover divided.

PLATE VI

FIG. 55.—Thirteen neck canal cells and ventral cell; intercalary growth in peripheral cells of neck.

FIG. 56.—Fourteen neck canal cells, ventral canal cell and egg; ninth and tenth canal cells from ventral cell in division; cover cell dividing into 2 almost equal segments by wall perpendicular to base; apical activity now brought to an end.

FIG. 57.—Fourteen neck canal cells and ventral cell; ninth neck canal cell from ventral cell in division.

FIG. 58.—Eighteen neck canal cells and ventral cell; seventh and eighth neck canal cells from ventral cell in division; cover shows 3 segments in median longitudinal section.

FIG. 59.—Eighteen neck canal cells, ventral canal cell, and egg; eleventh and twelfth neck canal cells in division.

FIG. 60.—Twenty neck canal cells and ventral cell; fifth and sixth neck canal cells in division; peripheral cells showing intercalary divisions.

FIG. 61.—Thirty neck canal cells, ventral canal cell, and egg; 2 uppermost neck canal cells in division; cover shows 3 segments in median longitudinal section.

FIG. 62.—Forty-three neck canal cells, ventral canal cell, and egg; cover shows 3 segments in median longitudinal section.

FIG. 63.—Cross-section of venter of mature archegonium at level of egg, showing variable number of cells in thickness.

PLATE VII

FIG. 64.—Terminal portion of an archegonium approaching maturity with the 10 neck canal cells in simultaneous division.

FIG. 65.—Terminal portion of an archegonium approaching maturity showing marked enlargement of canal and multiple condition of canal row.

FIG. 66.—Middle portion of neck of an archegonium showing multiplication of neck canal cells.

FIG. 67.—Lower portion of an archegonium nearly mature showing 3 neck canal cells in simultaneous division.

FIG. 68.—Lower portion of an archegonium practically mature showing multiplication of canal cells; ventral canal cell and egg almost equal in size.

FIG. 69.—Series of transverse sections through terminal portion of a mature archegonium showing multiple condition of neck canal row.

PLATE VIII

FIG. 70.—Venter with 3 cells, 2 lowest are probably eggs; uppermost is probably ventral canal cell.

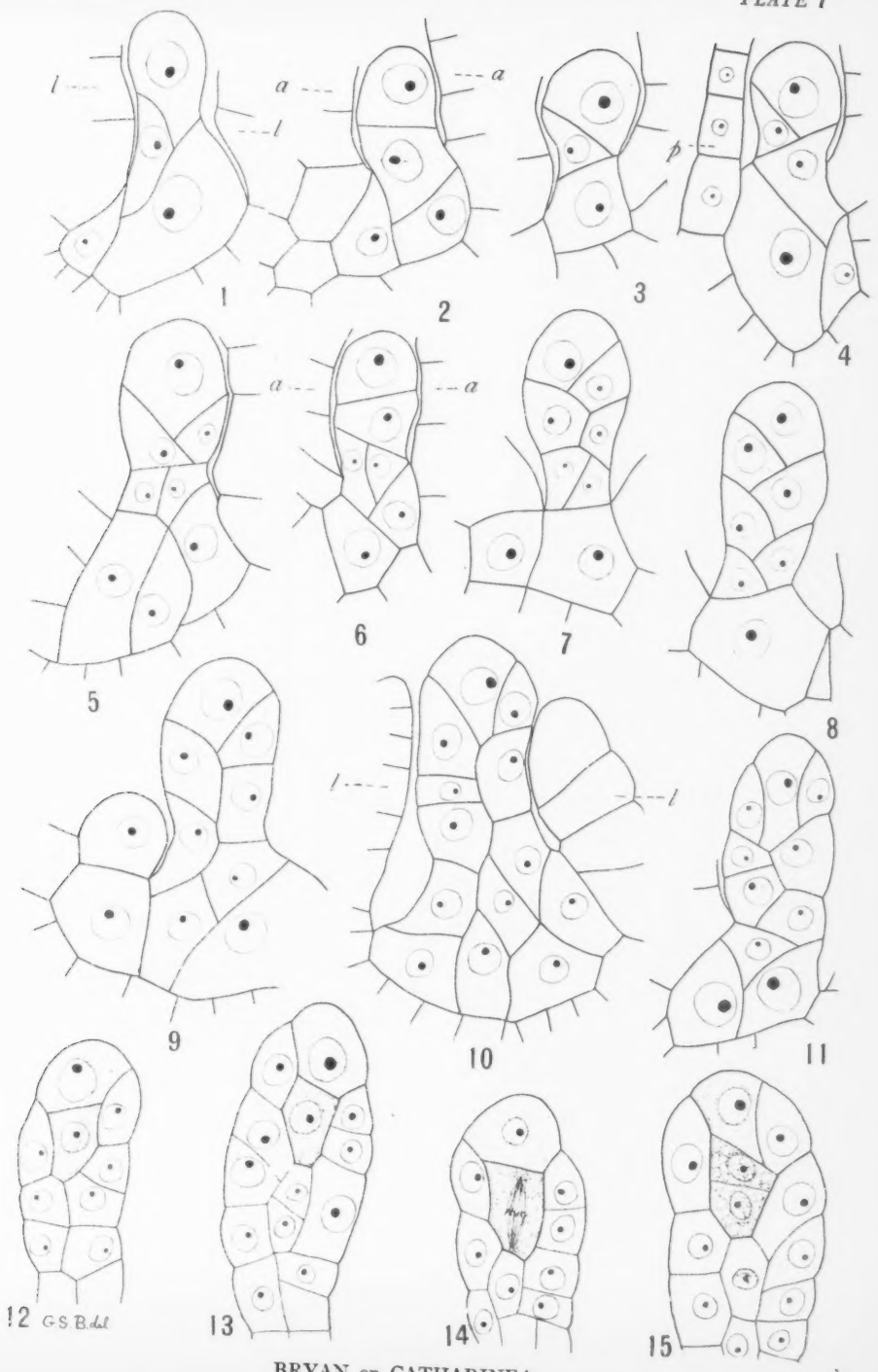
FIG. 71.—Double archegonium.

FIG. 72.—Serial sections through upper part of an archegonium containing 35 neck canal cells, ventral canal cell and egg; section *A* shows in cover cell: 1–1, primary division wall; 2–2, quadrant division; and further division in each quadrant; series shows variations in number of peripheral cells of neck.

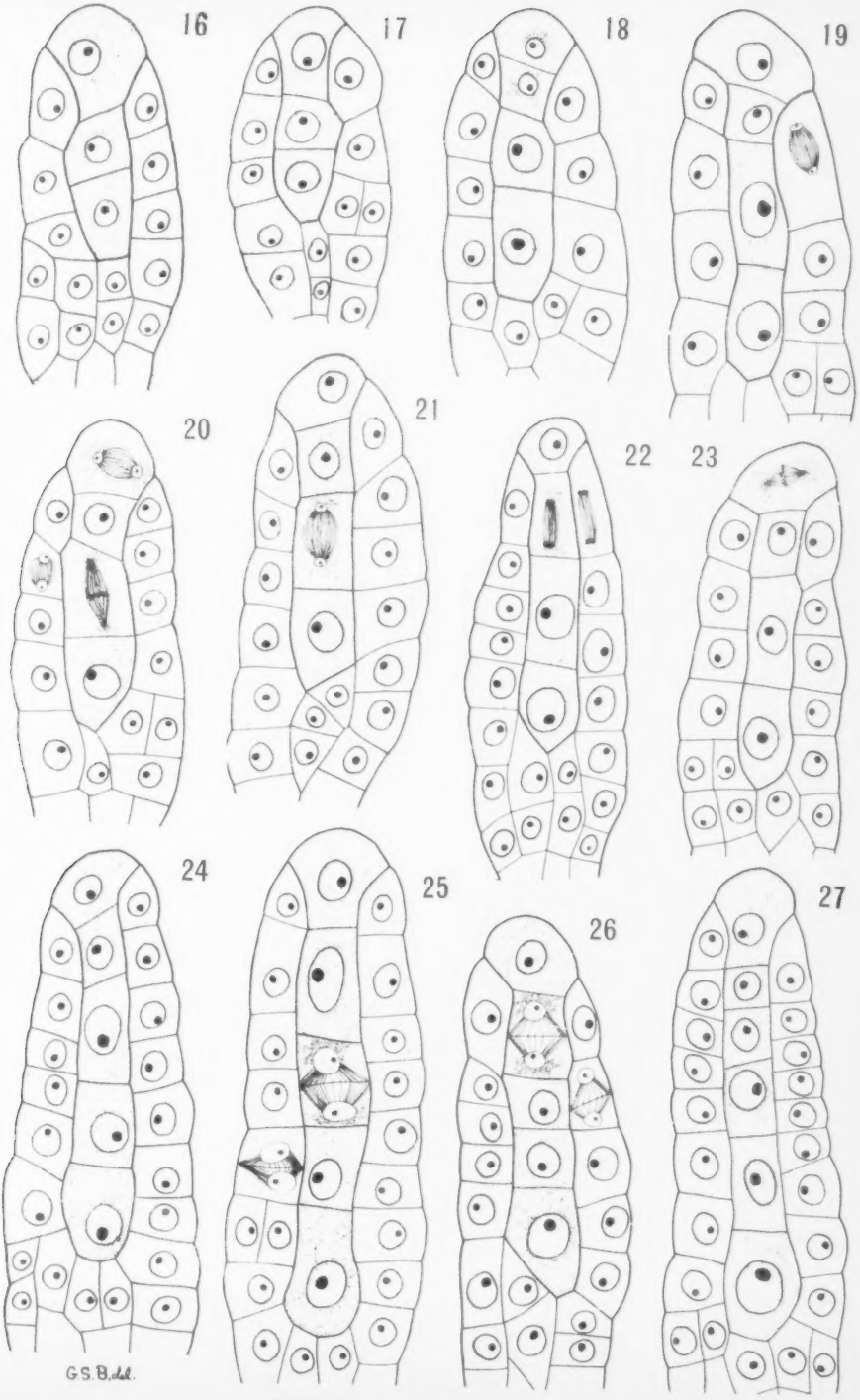
FIG. 73.—Serial sections through middle portions of neck of same archegonium showing remarkable regularity in number of peripheral cells of neck.

FIG. 74.—Serial sections through lower portion of same archegonium showing thickness just above venter (*A–D*); venter at level of ventral canal cell (*E*); venter at level of egg (*F*).

PLATE I



BRYAN on CATHARINEA



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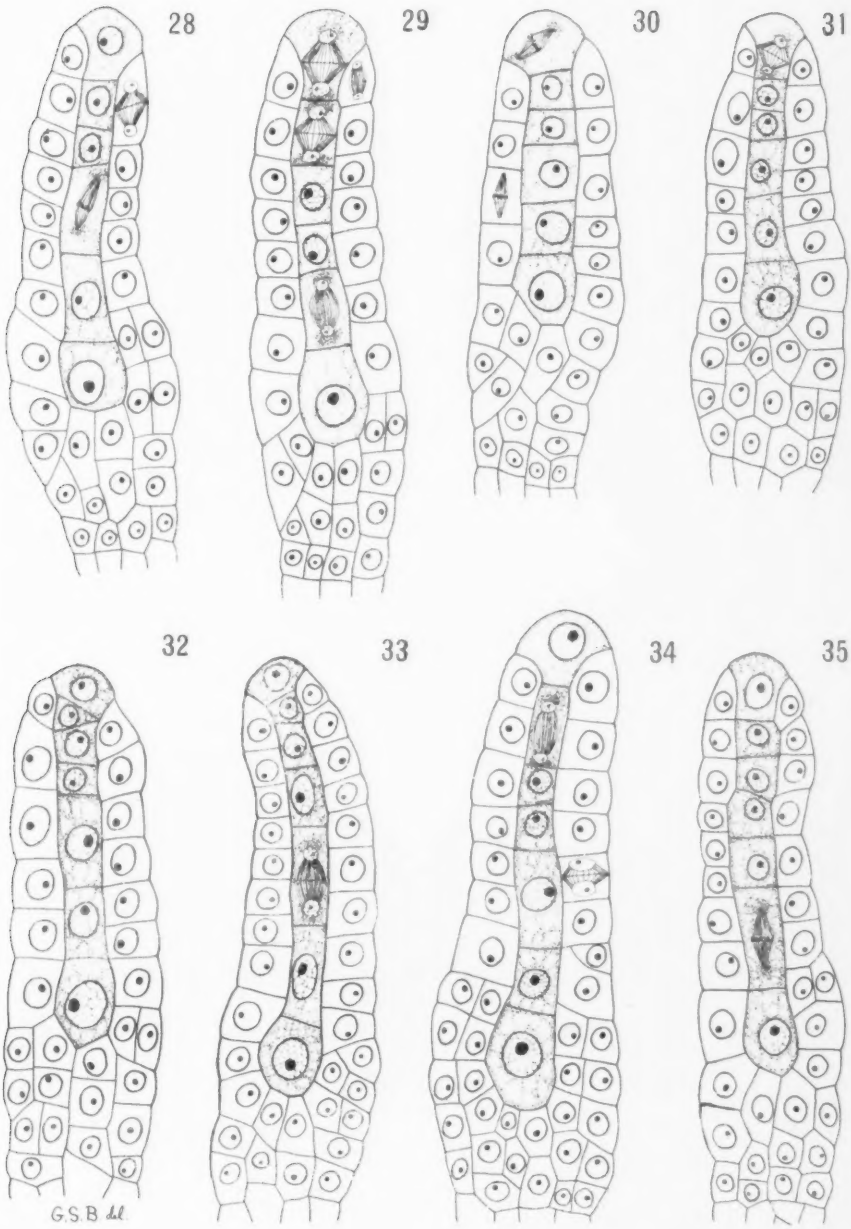

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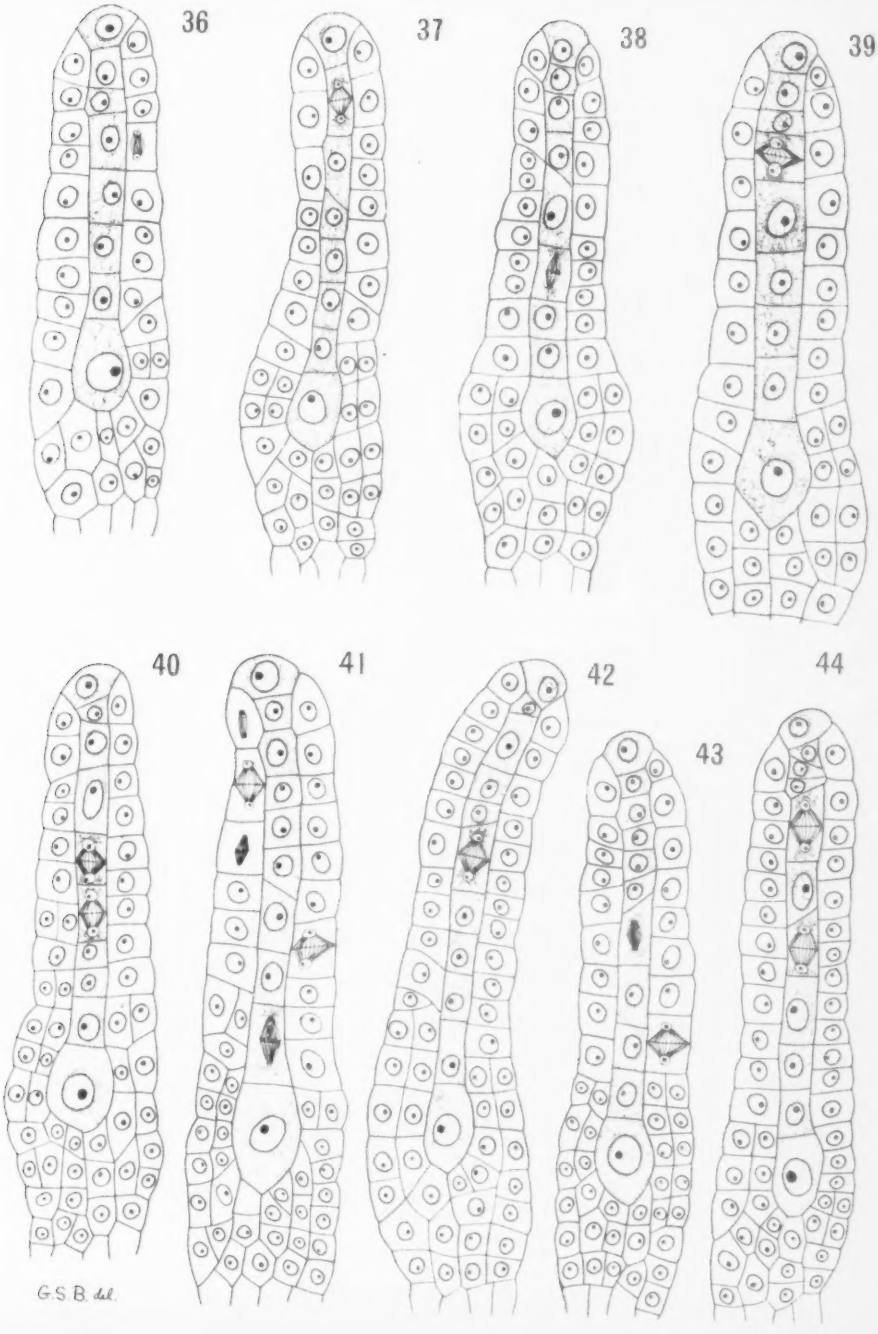

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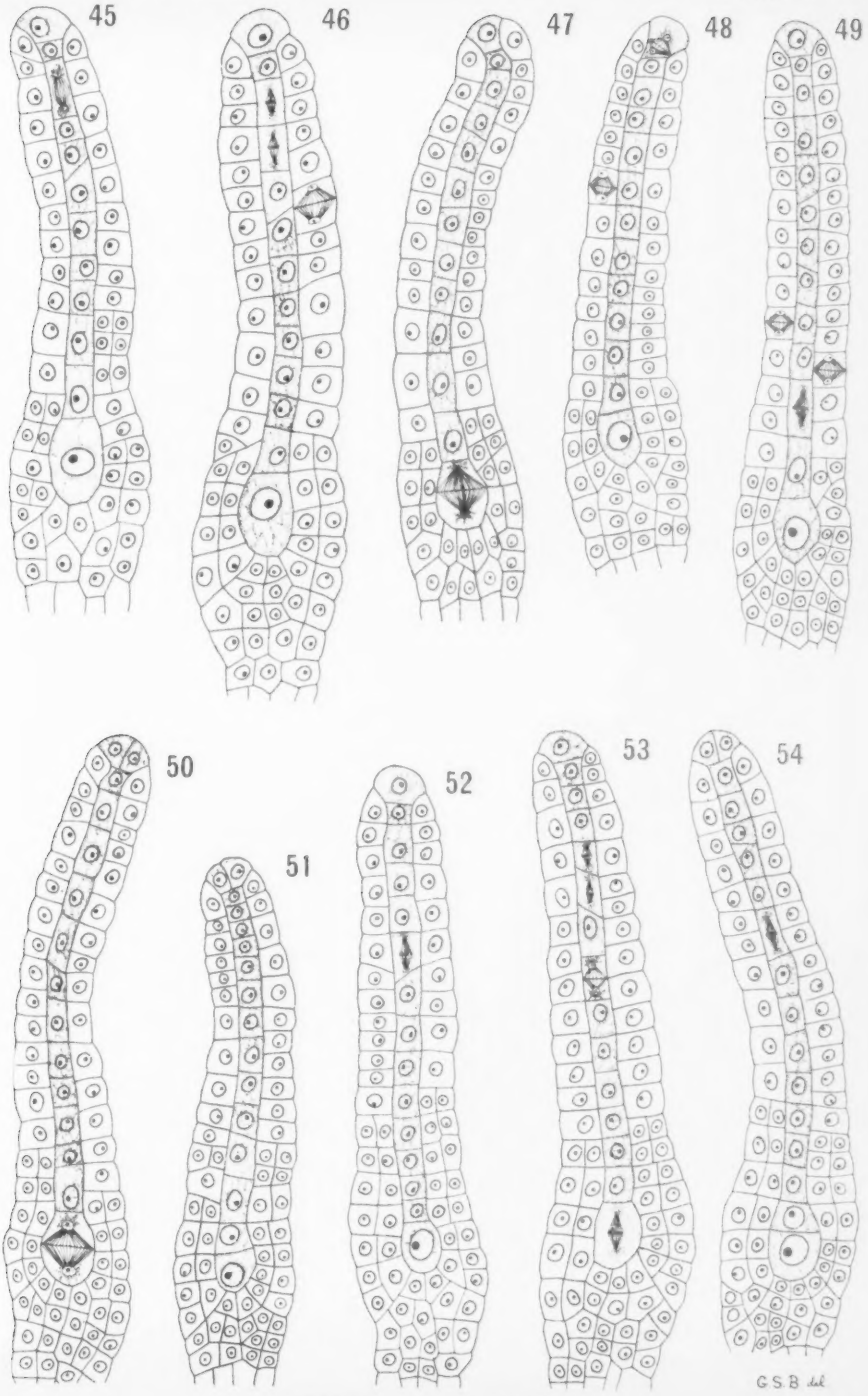

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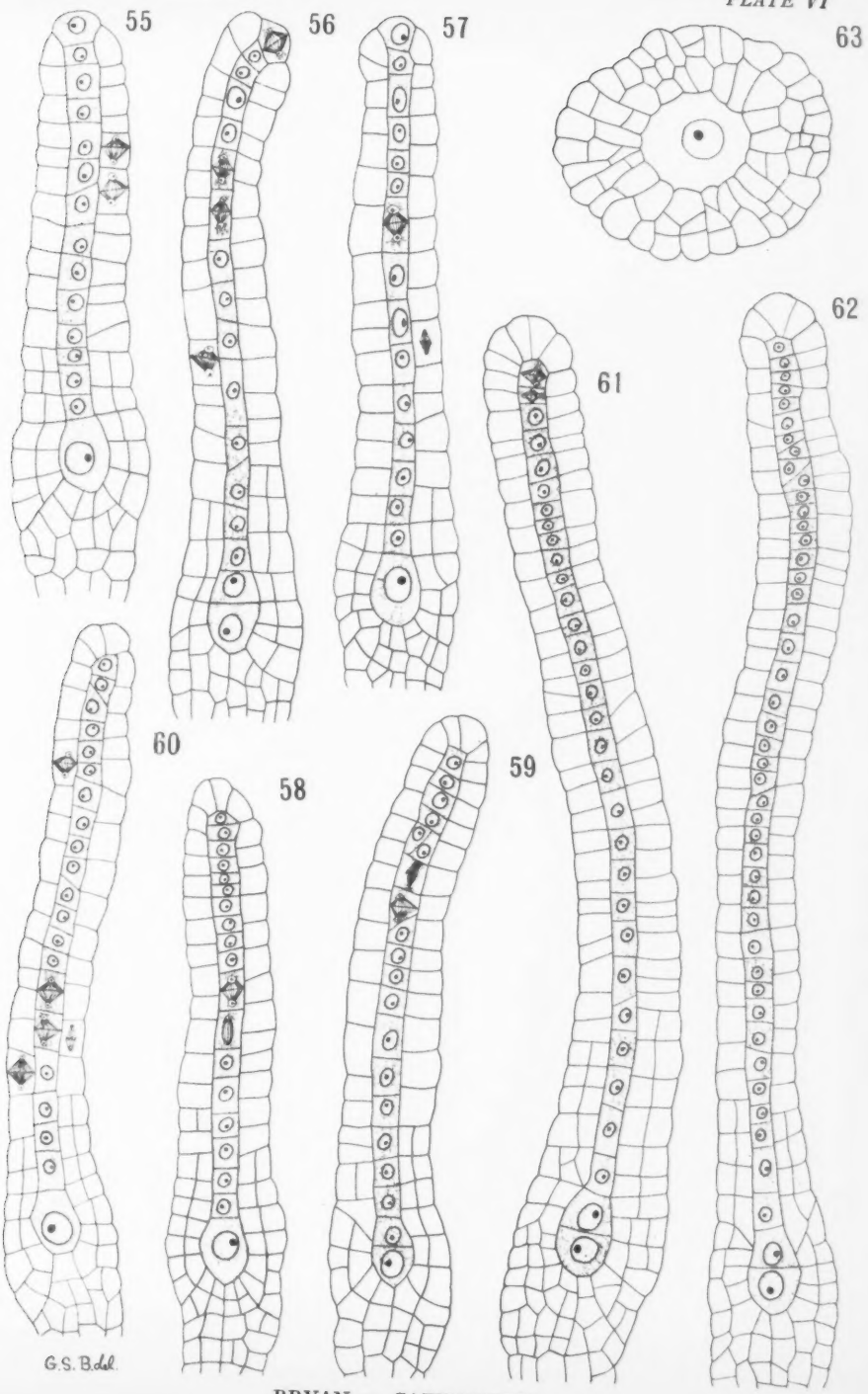

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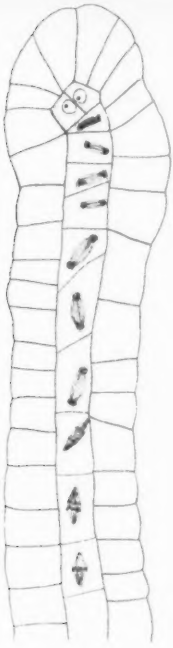

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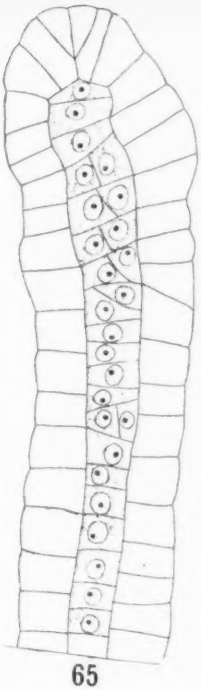

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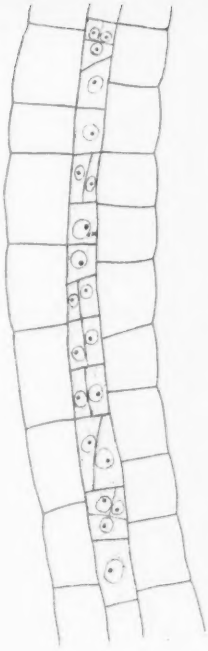

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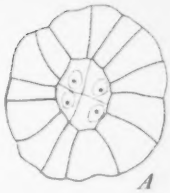

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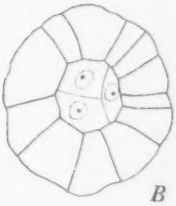

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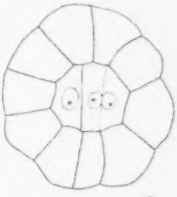

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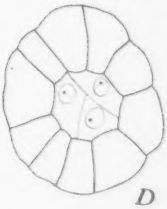

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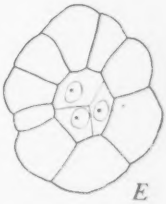

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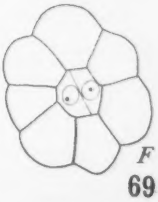

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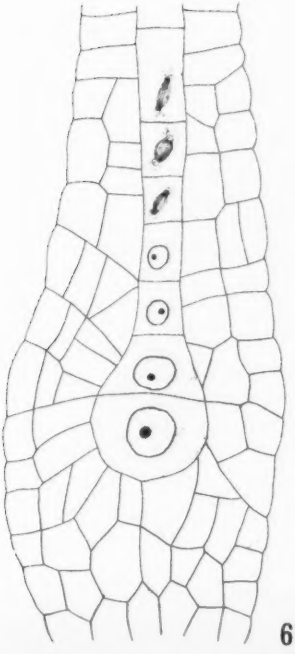

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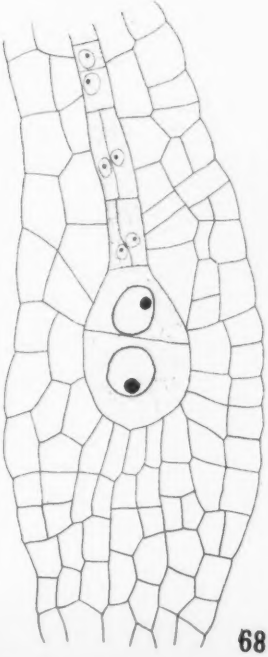

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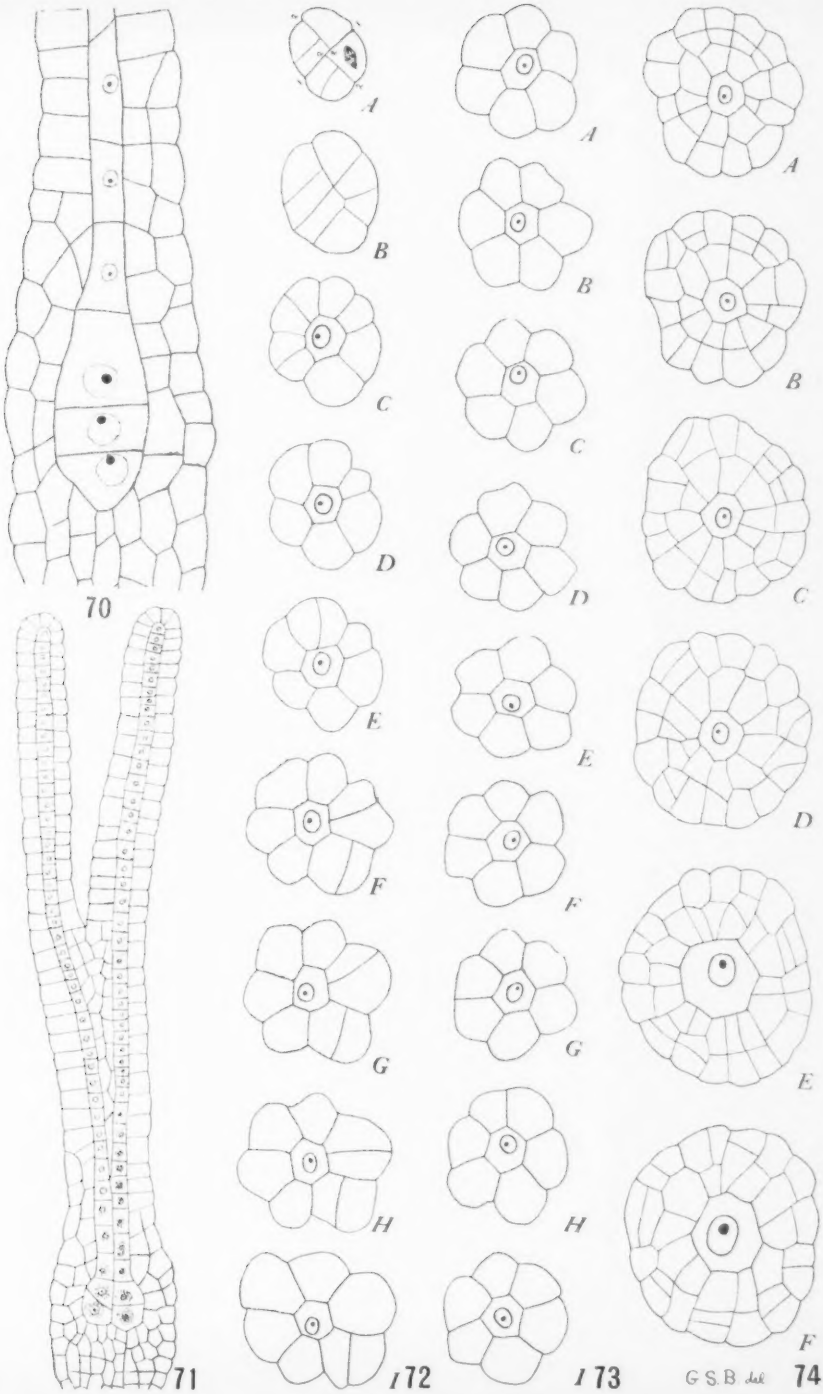
G.S.B. del.

BRYAN on CATHARINEA



BRYAN on CATHARINEA

STUDIES IN THE GENUS BIDENS. IV

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY 232

EARL E. SHERFF

(WITH PLATES IX AND X)

Bidens mollifolia, sp. nov.—Herba annua, 1.2–1.8 m. alta (ex inscriptione Pringlei); caule et ramis plus minusve acute tetragonis, subviridibus aut purpurascentibus, dense tomentosis (aut supra etiam fere glabris); ramis ad finem liberum in aliquot ramulos aut pedunculos divisis, ut quaeque planta 30–60 capitula habeat. Folia opposita, petiolata, petiolo adjecto 2–9 cm. longa, ternata aut pinnata, dense et molliter pilosiuscula aut tomentosula, infra pallidiora; foliolis (3–7) ovatis aut lanceolatis, serratis, lateralibus (infimis interdum ternatis) 1–3.5 cm. longis et 0.5–2 cm. latis, terminali 1.8–5 cm. longo et 0.7–2.3 cm. lato; petiolis dense tomentosis, basi connatis, 0.3–2.5 cm. longis. Capitula breviter pedunculata pedunculis 0.5–3 cm. longis, ligulata, 5–7 mm. alta et ad anthesin et in fructu, ligulis adjectis 1.5–2 cm. lata. Involucrum basi hispidum, squamis duplici serie dispositis; exterioribus (6–8) linearibus, ad apicem obtusis, sparsim hispidis et plus minusve ciliatis, 2–3 mm. longis; interioribus lanceolatis, maximam partem glabris, margine diaphanis, 3–5 mm. longis. Ligulae (circ. 5) obovatae aut oblanceolatae, rosaceae, 3–7-striatae, apice 2–4-lobulatae lobulis subrotundis, 0.8–1 cm. longae. Paleae lineares, margine diaphanae, demum 5–7 mm. longae et terminis tortis achaenia superantes. Achaenia subtetragona, clavae similima, infra angustiora, apici calva et areolata, nigra, glabra, 3–4 mm. longa.

C. G. Pringle 6050, at altitude of 2285 m., Sierra de San Felipe, Oaxaca, Mexico, November 16, 1894 (type in Herb. Gray); *E. W. Nelson* 1176 *pro parte*, at altitude of 2875–3353 m., in vicinity of Cerro San Felipe, Oaxaca, Mexico, September 1, 1894; *idem* 1363, at altitude of 2285–2875 m., 29 km., southwest of City of Oaxaca, Oaxaca, Mexico, September 10–20, 1894; *idem* 1476 *pro parte*, at altitude of 1675–2285 m., Valley of Oaxaca, Oaxaca, Mexico, September 20, 1894. All the specimens examined had been determined as

Bidens leucantha (L.) Willd. or *B. pilosa* L.; but in tall, slender habit, nature of pubescence, and short, clavate, exaristate character of fruit they are very distinct from either of these species.

Bidens cornuta, sp. nov.—Herba annua, 3–5 dm. alta; caule et ramis tetragonis, striatis, glabris, tenuibus. Folia opposita, petiolata, petiolo adjecto 3–12 cm. longa, 3–6 cm. lata, pinnata (aut summa bipinnata), ciliata, supra subglabra, infra sparsim adpresso-hispida; foliolis vel dentatis vel incisis vel etiam (imis foliorum superiorum) distincte partitis, ovatis aut lanceolatis; petiolis 0.3–3 cm. longis, glabris, ad basim hispidam connatis. Capitula terminalia, discoidea (aut interdum subligulata?), tenuiter pedunculata pedunculis 2–9 cm. longis. Involucrum basi glabrum, squamis duplici serie dispositis; exterioribus (5–8) linearibus, glabris aut infra hispido-ciliatis, 2–3 mm. longis; interioribus late linearibus, glabris, striatis, margine diaphanis, 4–5 mm. longis. Paleae lineares, striatae, margine diaphanae, demum 5–10 mm. longae. Achaenia anguste linearia, striata, triaristata; maturis aristis longis (5–7 mm.) et divaricatis, supra tenuissime et retrorsum hamosis, demum plus minusve deciduis; quibusdam exteriorum achaeniorum subbadiis, hispidis, 6–10 mm. longis; interioribus elongato-attenuatis, nigris vel subnigris vel ad apicem subflavidis, infra glabris, supra hispidis, 1.3–2 cm. longis.

Dr. Edward Palmer 131, at altitude of 730 m., Hacienda San Miguel, southwestern Chihuahua, Mexico, August, 1885 (type in Herb. Gray).

ASA GRAY had treated this plant as "*Bidens bipinnata* L. var. aristis demum patentissimis"; but from *B. bipinnata* it differs decidedly in its less divided foliage, its narrower, more elongated, fewer-fruited heads, and its peculiar achenes with awns (when still attached) diverging so that, especially if pressed flat on the herbarium sheet, they suggest narrow horns. The specific description given above is drawn up from the type and various cotypes studied in different American herbaria. These vary considerably in the amount of dissection of the foliage, but all display very uniformly the peculiar fruit characters.

Bidens leptocephala, sp. nov.—Herba annua, 1–5 dm. alta, glabra, ramosa; caule et ramis tetragonis, striatis, tenuibus. Folia opposita (aut summa alternata), petiolata, petiolo adjecto 2–10 cm. longa, 1.5–5.5 cm. lata, bipinnata (inferiora non saepe unipinnata), minute ciliata, minutissime hispida (praecipue ad

venas); petiolis 0.3–4 cm. longis, sparsim hispido-ciliatis, ad basim connatis. Capitula terminalia, subradiata aut discoidea, ad anthesin 3–5 mm. alta et (radiis comprehensis) 4–8 mm. lata, in fructu 1–1.5 cm. alta et solum 2–4 mm. lata, tenuissime pedunculata, pedunculis 2–8 cm. longis. Involucrum basi subglabrum, squamis duplici serie dispositis; exterioribus (4–6) linearibus, ciliatis, 1–2.5 mm. longis; interioribus dimidio longioribus, lanceolatis, glabris aut ad apicem pubescentibus, margine diaphanis. Ligulae (si praesentes) circiter 3, minimae, circ. 2.5 mm. longae et 1.2 mm. latae, integrae aut ad apicem bidentes, 4–5-striatae, subalbidae. Paleae anguste lanceolatae, striatae, margine diaphanae, demum 5–7 mm. longae. Achaenia pauca (5–9 aut etiam 13), subtetragona, linearia, biaristata aristis retrorsum hamosis; quaedam exteriora badia aut subnigra, hispida, 6–8 mm. longa; interiora nigra aut ad apicem helvola, infra glabra, supra hispida, 0.9–1.4 cm. longa.

J. C. Blumer 1712, in shade, sandy alluvium soil at altitude of 1615 m., near Cedar Gulch, Paradise, Chiricahua Mountains, Arizona, September 21, 1907 (type in Herb. Gray); *idem* 2144, at altitude of 1760 m., base of rhyolite slope, Wilgus Ranch, Chiricahua Mountains, Arizona, September 4, 1907; *Dr. J. M. Bigelow* (Lieut. A. W. Whipple's Explor. Exped.), Hurrah Creek, Fort Smith to the Rio Grande, September 25, 1853–54; *E. L. Greene* 263, banks of the Upper Gila River, New Mexico, August 29, 1880; *J. G. Lemmon* 333, near Fort Huachuca, Arizona, in 1882; *idem*, Apache Pass, Chiricahua Mountains, Arizona; *idem* 3029, near Fort Huachuca, Arizona, in 1883; *Mr.* and *Mrs. J. G. Lemmon*, Apache Pass, Fort Bowie, Arizona, September 1881; *C. G. Pringle* 62, near Arivaca, Arizona, August 31, 1884; *David Griffiths* 1985, Hudson Ranch, near Pierce, Arizona, October 1900; *idem* 5994, fenced area, Santa Rita Forest Reserve, Arizona, September 27—October 4, 1903; *idem* 6014, above Range Reserve, Santa Rita Mountains, Arizona, September 12—October 18, 1903; *J. J. Thornber* 72, at altitude of 1780 m., Stone Cabin Canyon, Santa Rita Mountains, Arizona, September 14, 1903; *Griffiths* and *Thornber* 65, Santa Rita Mountains, Arizona, September 20—October 4, 1902.

This species has been confused with *Bidens Bigelovii* Gray and *B. bipinnata* L. by various botanists. Thus, for example, Asa Gray determined a specimen of *Bigelow's* 581 as *B. bipinnata*, but *Lemmon's* 3029, which was identical, he designated on the label as "*Bidens Bigelovii* varying toward *B. bipinnata*." From these two species it differs very clearly in its more slender, delicate habit, and in its slender fruiting heads with their smaller number of achenes. In foliage, some of the larger specimens have leaves rather like those of *B. Bigelovii*.

Bidens Langlassei, sp. nov.—Herba (annua?) erecta, circiter 1 m. alta, parce ramosa; caule glabro, acute et perspicuissime quadrangulato, basi tumido et ligneo. Folia opposita, petiolata, petiolo adjecto 2.5–5.5 cm. longa, pariter 2.5–5.5 cm. lata, bi- aut tripinnata (summa pinnata aut indivisa), supra glabra, margine hispidulo-ciliata, infra remotissime hispida, ultimis segmentis linearissimis, 0.5–1 mm. latis, integris, acute apiculatis; petiolis 3–7 mm. longis, plus minusve hispido-ciliatis, basi connatis. Capitula terminalia, ligulata, tenuiter pedunculata, pedunculis 1–11 cm. longis. Involucrum basi sparsim hispidum, squamis duplici serie dispositis; exterioribus (12–16) linearissimis, fere glabris, 6–7 mm. longis; interioribus linearibus, margine diaphanis, circ. 3 mm. longis. Ligulae (6–7) flavae, subanguste ellipticae, 7–15-striatae, ad apicem denticulatae, circ. 1.5 cm. longae. Paleae squamis interioribus similes sed demum longiores. Achaenia immatura. Ovaria (1–1.3 mm. longa) subplana, apice annulo 10–15 setulorum coronato.

E. Langlassé 332, in clay soil at altitude of 1200 m., "Le Faixin," southern Mexico (perhaps Farascon, Michoacan), September 8, 1898 (type in Herb. Gray).

The description is drawn from the type and one cotype (the latter in U.S. Nat. Herb.).

Bidens capillifolia, sp. nov.—Herba tenuis, verisimiliter annua, +3 dm. alta, ramosa, glabra (aut ramis ad eorum basim hispida); caule et ramis subteretis, striatis. Folia opposita, petiolata, petiolo adjecto 2–6 cm. longa, pinnata, foliolis linearissimis, indivisis aut lobatis, margine integris, 0.5–1 mm. latis; petiolis 0.6–1.5 cm. longis, ad basim connatis. Capitula terminalia, discoidea, longe et tenuiter pedunculata, pedunculis 4–15 cm. longis. Involucrum basi plus minusve setoso-hispidum, squamis duplici serie dispositis; exterioribus (3–5) linearibus, glabris aut sparsim hispidis, 6–8 mm. longis; interioribus anguste lanceolatis, glabris aut sparsim hispidis, margine diaphanis, 4–6 mm. longis. Paleae lineares, margine diaphanae, demum 6–8 mm. longae. Achaenia linearia, tetragona, biaristata aristis retrorsum hamosis; 1–3 exteriora rufo-badia, sparsim tuberculato-hispida, circiter

6 mm. longa; interiora nigra (nisi ad apicem), elongata, glabra aut supra remote hispida, 9–14 mm. longa.

Barber and *Townsend*, Sierra Madre, Chihuahua, Mexico, July 17, 1899 (type in U.S. Nat. Herb., herb. no. 663169). The nearest known ally of this species is *Bidens tenuisecta* Gray, a plant with a less branched and less delicate habit, wider leaf divisions, and more hispid involucre. I have seen only the type specimen.

Bidens carpodonta, sp. nov.—Herba annua, erecta, 3–6 dm. alta; caule et ramis tetragonis, striatis, subglabris. Folia opposita, petiolata, petiolo adjecto 2–7 cm. longa, remotissime hispida, bi- aut tripinnata, ultimis segmentis linearibus, integris, 0.5–1.5 (raro 2.5) mm. latis, ad apicem acutis; petiolis ciliatis, basi connatis, 0.1–1.5 cm. longis. Capitula terminalia, ligulata, tenuiter pedunculata, pedunculis 3–10 cm. longis, ad anthesin ligulis adjectis 1.5–2.5 cm. lata et 0.6–1 cm. alta, in fructu 0.7–1 cm. lata et 0.8–1.2 cm. alta. Involucrum basi setoso-hispidum, squamis duplici serie dispositis; exterioribus (6–8) linearibus, hispido-ciliatis, indurato-apiculatis, 3–5 mm. longis; interioribus lanceolatis, margine diaphanis, glabris, paulo longioribus. Ligulae (circ. 5) flavae, ovatae, 12–15-striatae, apice 2–3-dentatae, 0.8–1 cm. longae. Paleae lineares, striatae, margine diaphanae, demum 5–8 mm. longae. Achaenia linearia, tetragona; quaedam exteriora subfusca, dense tuberculata, apice exaristato sed ad circumferentiam minute spinuloso-dentato, 4–6 mm. longa; interiora nigra, plerumque subsparsim tuberculato-hispida, demum elongata et 0.8–1 cm. longa, raro biaristata aristis nudis aut retrorsum 1–3-hamosis, sed plurimum exaristata, apice (erecte spinuloso-denticulato circulo) coronato.

Dr. Edward Palmer 419, San Lorenzo Canyon, 9.6 km. southeast of Saltillo, Coahuila, Mexico, September 21–23, 1904 (type in Herb. N.Y. Bot. Gard.).

Differs from *B. procera* Don in having achenes that are much more attenuate and lack elongate, numerously barbed aristae. From *B. Schaffneri* (Gray) Sherff it differs in general aspect of foliage and in its longer achenes. It is nearest to *B. ludens* Gray and might pass for that species except for its longer and much narrower achenes. A study of numerous specimens of *B. procera*, *B. Schaffneri*, and *B. ludens* has convinced me that these species, bearing at times a close superficial resemblance to each other and thus having been more or less confused in herbaria, are very definitely separable and have fruit

characters respectively constant. This being true, it seems certain that the 15 or more beautiful plants collected by *Palmer* (no. 419), and all of them having uniquely elongate, very attenuate achenes, are likewise specifically distinct.

Bidens pseudalausensis, sp. nov.—Herba, verisimiliter annua, circiter 6 dm. alta (ex Langlassei inscriptione), ramosa; caule et ramis tetragonis et acute angulatis, striatis, glabris. Folia opposita, petiolata, petiolo adjecto 2–7 cm. longa, 1–5.5 cm. lata, bipinnata, glabra; ultimis lobis cuneato-oblanceolatis, dentatis dentibus ad apicem induratis; petiolis 0.2–2 cm. longis, ad basim connatis, Capitula terminalia, tenuiter pedunculata pedunculis 1.5–6 cm. longis, ligulata, ad anthesin 6–7 mm. alta et (ligulis adjectis) circ. 1.5 cm. lata. Involucrum basi glabrum, squamis duplici serie dispositis; exterioribus (circ. 8) linearibus, ciliatis, 2–3 mm. longis; interioribus paulo longioribus, glabratis, margine diaphanis. Ligulae (circ. 5) albae (e Langlasseo), in sicco specimine luteolae, striatae, obovatae, ad apicem lobulatae aut obtusissime dentatae, 5–7 mm. longae. Achaenia (1–3 maturata in capitulis singulis) linearia, nigra, faciebus plus minusve glabra, marginibus tuberculato-hispida, biaristata (aristis sub apicem retrorsum hamosis), 7–9 mm. longa.—Differt a *B. alausensi* H.B.K. habitu ramoso, etc.

E. Langlassé 541, at altitude of 580 m., "El Ocote, Cerro Pedregoso, Michoacan and Guerrero," Mexico (type in U.S. Nat. Herb.).

Bidens aequisquama (Fernald), comb. nov.—*Bidens rosea* Schz. Bip. var. *aequisquama* Fernald, Proc. Amer. Acad. **43**:68. 1907.

This rare species differs very markedly from *Bidens rosea* Schz. Bip., not only in its involucres but also in its foliage and achenes. The type of *B. rosea* (*Cosmos pilosus* H.B.K.) is still extant (in Herb. Mus. Hist. Nat. Paris) and, though rather immature, is not separable from such specimens as *Heyde* and *Lux* 6172 and *Palmer* 192 (cf. GREENMAN, Proc. Amer. Acad. **41**: 264. 1905). From a study of numerous specimens that occur in different herbaria it is seen that *B. rosea* has a very slender, upwardly narrowed type of achenes, produced in rather small heads. Their aristae at maturity are mainly devoid of barbs. In some material (for example, *Heyde* and *Lux* 6164, Guatemala, 1894, a form with bipinnate leaves) the aristae are very short or even obsolete. But in *B. aequisquama* the achenes are in larger heads and are thicker. They are not narrowed above. Their aristae are much more

conspicuous, averaging ⅓ to ½ the length of the achene body, and are armed with many retrorse barbs that are not deciduous. Many other characters likewise are pronounced, making it seem best, therefore, to give herewith a full specific description, drawn from the type and various cotypes examined.

BIDENS AEQUISQUAMA, descript. amplificat.—Herba, +5 dm. alta; caule ramisque pubescentibus aut subglabris, quadrangularibus, striatis. Folia opposita, petiolata, petiolo adjecto 3–8.5 cm. longa, indivisa aut tripartita, ciliata, supra subglabra, infra sparsim adpresso-hispida et pallidiora; indivisis foliis lanceolatis, subcrasse serratis; foliolis foliorum tripartitorum similiter serratis, terminalibus ovatis aut lanceolatis, lateralibus ovatis et subsessilibus et minoribus; petiolis 0.4–1.8 cm. longis, hispidis, ad basim connatis. Capitula terminalia, ligulata, pedunculata, pedunculis 1–6 cm. longis et ad apicem creberrime albido-pubescentibus. Involucrum basi hispidum; squamis duplici serie dispositis; exterioribus (9–16) linearibus, hispidis, 2–4 mm. longis; interioribus subaequalibus, lanceolatis, glabris aut ad apicem et longitudinaliter medio hispidis, margine diaphanis. Ligulae (circ. 8) roseae, striatae, apice irregulariter 2–4-dentatae, 9–11 mm. longae, 6–8 mm. latae. Paleae lineares, margine diaphanae, 4–6 mm. longae. Achaenia nigra, linearia, ad apicem plus minusve hispida, biaristata, aristis non adjectis 4.5–7 mm. longa, flavis aristis retrorsum hamosis et 2.5–3 mm. longis.

"BIDENS SEEMANNII" Schz. Bip., ex Seem. Bot. Herald 307. 1852–57; *Cosmos Seemannii* Gray, Proc. Amer. Acad. **19**: 16. 1883.

SCHULTZ BIPONTINUS believed the genus *Cosmos* to be unworthy of separate treatment and accordingly he united it with *Bidens*. But since his time, special students of the Compositae have persisted very uniformly in recognizing *Cosmos* as a distinct genus (cf. GREENE, Pittonia **4**: 245. 1901). Indeed, the characters of the type species of that genus (*Cosmos bipinnatus* Cav.) are so pronounced as to make it very improbable that SCHULTZ BIPONTINUS' view will ever be accepted by botanists in the future. This being the case, there arises a slight difficulty in fixing upon the characters by which most accurately to distinguish between *Cosmos* and *Bidens*. The technical character most noticeable

in a number of *Cosmos* species is the rostrate achenes. *Cosmos bipinnatus* Cav., *C. parviflorus* H.B.K., *C. caudatus* H.B.K., *C. sulphureus* Cav., and *C. ocellatus* Greenm. are among those species displaying this character in a marked degree. A study of such species shows that the rostrate achenes are accompanied in *almost* every case by two other characters; namely, some shade of red in the ligules and the appearance of the interior involucre in the somewhat immature heads, suggesting the conspicuous inner involucre found so commonly in species of *Coreopsis*. But there are a few species of *Cosmos* in which the mature achenes tend to be erostrate. Thus, *Cosmos crithmifolius* H.B.K. and *C. linearifolius* (Schz. Bip.) Hemsl., in the many specimens that I have seen, fail almost uniformly to exhibit achenes swollen below and distinctly long-rostrate above as in *C. bipinnatus*. Yet in color of ligules and character of involucre they harmonize perfectly with *Cosmos*. While neither of these two characters is absolutely diagnostic, their simultaneous occurrence, coupled with a tendency of the central achenes at maturity to be elongate, even though indistinctly rostrate, shows both species to be true *Cosmos* beyond all question, and not *Bidens*.

HEMSLEY (Biol. Centr. Amer. **2**: 203. 1881), in dealing with the Compositae of Mexico, very correctly considered these two species as belonging to *Cosmos*. But "*Bidens Seemannii*," a species so identical *generically* with *Cosmos crithmifolius* that HEMSLEY himself erroneously referred to it *Parry* and *Palmer* 485 (true *C. crithmifolius*), he retained as *Bidens*. At a later date ASA GRAY suspected *Ghiesbreght* 264 of being "*Bidens Seemanii*" and stated that, if it was, the name should become *Cosmos Seemannii* (Proc. Amer. Acad. **19**: 16. 1883). In Gray Herbarium, the Ghiesbreght specimen studied by GRAY is still preserved in good condition. It is identical with *Seemann* 2014 (in Herb. Kew), thus confirming GRAY'S supposition. It is accompanied by a letter to GRAY from HEMSLEY, which must have been written later than 1881 and probably later than 1883 (the dates of the two works above cited). In this letter HEMSLEY, speaking of "*Bidens Seemannii*," wrote, "I do not see how *C. crithmifolius* differs generically."

GREENMAN (Proc. Amer. Acad. **41**: 265. 1905), relying upon the erostrate achenes, retained "*B. Seemannii*" in *Bidens*. But, as might be inferred already, if this treatment were to be adopted, then the subgeneric congeners of this species, such, for example, as *Cosmos crithmifolius*, would likewise have to be placed in *Bidens*, a procedure that surely would meet with little acceptance, if any. Thus it seems best to follow the views of GRAY and HEMSLEY in this matter and treat the species as *Cosmos Seemannii* (Schz. Bip.) Gray.

Besides the specimens of *C. Seemannii* listed by GREENMAN (*loc. cit.*), I have examined the following: *J. N. Rose* 3435, in the Sierra Madre, near Santa Teresa, Terr. de Tepic, Mexico, August 11, 1897; *Dr. Edward Palmer* 1852, Tepic, Terr. de Tepic, Mexico, January 5—February 6, 1892; *Arsène*, Cerro San Miguel, Morelia, Mexico, February 1909.

"BIDENS PALMERI" Gray, Proc. Amer. Acad. **22**: 429. 1887.

This species, with its strongly ribbed leaves, is very close to *Cosmos crithmifolius* H.B.K., but differs in its yellow rays and slightly different leaf outline. In most specimens the achenes are clearly erostrate, but occasionally some of the central achenes become highly elongated above, appearing almost distinctly rostrate and thus exactly simulating those of such species as *Cosmos crithmifolius* and *C. linearifolius*. This is especially notable in certain material collected by *Barnes* and *Land* (nos. 164 and 189, in Herb. Field Mus.). In fact, the subrostrate character of the achenes was known to GRAY (cf. GRAY, *loc. cit.*, "acheniis subulatis . . . subrostratis"). Yet, curiously enough, he placed this species in *Bidens*, while previously (Proc. Amer. Acad. **19**: 16. 1883) he had given the name *Cosmos Seemannii*, as shown above, to the Ghiesbreght plant, described by himself as having "essentially beakless . . . . achenes."

As this plant belongs very properly in *Cosmos*, it is renamed **Cosmos Landii,** nom. nov.[1]

I have examined the following specimens: *Dr. Edward Palmer* 315, Rio Blanco, Jalisco, Mexico, August 1886; *C. G. Pringle* 2348, vicinity of Guadalajara, Jalisco, Mexico, November 2, 1889; *idem* 11490, banks of ravines at

[1] In honor of Dr. W. J. G. LAND of the University of Chicago, the excellent specimens collected by him and C. R. BARNES having served materially to extend our conception of this species.

altitude of 1525 m., Rio Blanco near Guadalajara, Jalisco, Mexico, October 6, 1903; *C. R. Barnes* and *W. J. G. Land* 164 and 167, at altitude of 1707 m., Sierra de San Estaban, Jalisco, Mexico, September 28, 1908; *idem* 189, at altitude of 1737 m., Sierra de San Estaban, Jalisco, Mexico, September 28, 1908.

BIDENS TENUISECTA Gray, Plant. Fendl. 86. 1849; *Bidens cognata* Greene, Leafl. Bot. Crit. **1**: 149. 1905.

In describing *Bidens cognata*, GREENE (*loc. cit.*) stated that it was "allied to *B. heterosperma*." He then proceeded to differentiate it from that species, which was very easy to do because *B. heterosperma* was so unlike it. Here, as in certain other cases (cf. SHERFF, BOT. GAZ. **56**: 494. 1913), GREENE's error consisted in referring the plant to the wrong species and then founding a new species upon the points of dissimilarity. His type material (*O. B. Metcalfe* 1436) is merely a low, rather much branched form of *Bidens tenuisecta* Gray, with the type of which (in Herb. Gray) it is connected by numerous specimens in American herbaria.

"BIDENS DILLENIANA" Hill, Veg. Syst. **3**: 123. 1761.

This name seems to have escaped the serious attention of botanists for more than a century and a half. The *Index Kewensis*, although it cites the name, does not cite the habitat. HILL himself (*loc. cit.*) called it the "dwarf hemp agrimony" and stated that it was a British plant ("a petty plant of our own country"), but his generalized illustration and brief description were entirely too vague for satisfactory determination. However, on turning to his earlier work (Brit. Herb. 461. 1756), we find (under *Verbesina*) a much fuller description of the dwarf hemp agrimony, along with descriptions of what are now known as *Bidens cernua* L. and *B. tripartita* L. This description and the earlier name cited there by HILL, *Verbesina minima* Ray, show positively that the plants later named *Bidens Dilleniana* were merely the dwarf bog form of *Bidens tripartita* L. or the similar form of *B. cernua* L. (or very likely both these forms without distinction).

The name *Dilleniana* was given evidently for the very reason that DILLENIUS (Cat. Plant. Giss. 167, App. 66. 1719; ex Ray, Syn. 188. *pl. 7. fig. 2.* 1724) was the one to introduce the name *Verbesina minima* which HILL sought to displace.

BIDENS TRIPARTITA L. Sp. Plant. 831. 1753.

DRUCE (Fl. Berks. 283. 1897) has treated the dwarf form of this species as "forma *minima*." But it should be noted that DRUCE is not the first author to adopt this status, LARSSON (Fl. Werml. 221. 1859) having used it long before. Similarly, the dwarf form of *B. cernua* L., named "forma *minima*" by DRUCE (Herb. Dillen. 67. 1907), evidently under the impression that such treatment was new, was already described, years before, as *B. cernua* f. *minima* (Larss., *loc. cit.*, 220).

BIDENS CERNUA L. Sp. Plant. 832. 1753; *Bidens Kelloggii* Greene, Pittonia **4**: 267. 1901.

A careful study of the type and other cited specimens of *Bidens Kelloggii* (in U.S. Nat. Herb.) shows them to be incapable of separation from *B. cernua*. GREENE classed these forms among the segregates from *B. laevis* (L.) B.S.P., but most inconsistently so, for, at the same time, he even stated that "DR. TORREY . . . . more correctly referred them to *B. cernua*."

It may be remarked in passing that, in the future, supposedly new species allied with *Bidens cernua* should be described only after taking the utmost care to see that they are not mere atypic forms of that species. It would be interesting to subject *B. cernua* to elaborate breeding experiments. A beginning in this direction has been made already by GUPPY (Studies in Seeds and Fruits 480. 1912).

BIDENS ALBA DC. Prodr. **5**: 605. 1836.—*Coreopsis alba* L., Sp. Plant. 908. 1753; *Chrysanthemum americanum, ciceris folio* . . . . Herm. Par. 124. *pl. 124*. 1698; *Bidens pilosa* L. var. *alba* O. E. Schulz (*excl. synon. maximam partem*), Urb. Symb. Antill. **7**: 136. 1911; *Bidens dondiaefolia* Less. (ex descript. et loci situ), Linnaea **5**: 155. 1830.

This peculiar plant was treated by DECANDOLLE as one of the "species non satis notae." LINNAEUS' description ("foliis subternatis cuneatis serratis") and citation of habitat ("Insula St. Crucis") were drawn directly from the work of HERMANN, the Paradisus Batavus. Reference to this work (*loc. cit.*) shows a plant very unique in habit, especially as to its many foliose, sterile shoots and its cuneate leaf divisions. So rare has this form been in herbaria that it is easy to understand DECANDOLLE'S misgivings

regarding it. Recently, however, there has come to hand (in Herb. Field Mus.) a specimen (*C. R. Orcutt* 2886, Vera Cruz, Mexico) which agrees most minutely and strikingly with Hermann's plate which LINNAEUS cited; also another (*idem* 2991, Sanborn, Vera Cruz, Mexico) agreeing satisfactorily but having proliferous heads. Coming from the same locality in Mexico are other specimens which show transitions to a more elongate type of plant with some 5-parted leaves. One of these (*Mueller* 148, in Herb. N.Y. Bot. Gard.) is labeled *Bidens dondiaefolia* Less., a species likewise from Vera Cruz and the description of which it fits very well (I have not yet seen LESSING's type). It is noteworthy that LESSING called attention to the sterile shoots of this species; "rami plures steriles."

From these facts it is evident that *B. dondiaefolia* Less. is a synonym for *B. alba* (L.) DC., and that *B. alba* is a local species native mainly to the state of Vera Cruz, Mexico. It possibly does not occur in St. Croix, as stated by HERMANN (*loc. cit.*). Dr. C. F. MILLSPAUGH, himself an authority upon the flora of St. Croix, suggests to me, and very plausibly so, that in the preparation of HERMANN's posthumous work, the name "Sancta Crux" perhaps became substituted for "Vera Crux," and that thus the locality "Insula St. Crucis" finally was published.

As to the worthiness of *Bidens leucantha* (L.) Willd. to rank separately from *B. alba*, future field observations and breeding tests are highly desirable. It seems much the safer course to retain the two names separately for the present rather than merge them as done by O. E. SCHULZ (*loc. cit.*).

The plant collected by *Ghiesbreght* (no. 551) and referred by GRAY (Proc. Amer. Acad. **19**: 16. 1883) to *B. dondiaefolia* is a very different plant and is typical *B. chiapensis* Brandeg. The following list represents the specimens of *B. alba* so far determined by myself at the Field Museum and the New York Botanical Garden (certain numbers appearing to accompany mixed material elsewhere).

Fred Mueller 148, Vera Cruz, Mexico, August 1853; *idem* 4067, Orizaba, Vera Cruz, Mexico (in 1855?); *J. M. Greenman* 6, near wharf, City of Vera Cruz, Vera Cruz Mexico, January 22, 1906; *idem* 23, La Laguna, near City

of Vera Cruz, Vera Cruz, Mexico, January 22, 1906; *idem* 97, along the shore, north of City of Vera Cruz, Vera Cruz, Mexico, January 24, 1906; *C. R. Orcutt* 2886, Vera Cruz, Mexico, February 16, 1910; *idem* 2991, Sanborn, Vera Cruz, Mexico, April 18, 1910.

BIDENS HUMILIS H.B.K., Nov. Gen. et Sp. **4**: 234. 1820.—*Bidens consolidaefolia* Turcz., Bull. Soc. Nat. Mosc. **24**: 185. 1851.

TURCZANINOW (*loc. cit.*) based his species *Bidens consolidaefolia* upon *Jameson* 693 from Quito. At Gray Herbarium is one sheet of specimens by JAMESON "from the vicinity of Quito and elsewhere," and the specimens at the top of the sheet, while lacking a number, match precisely the description of *B. consolidaefolia*. It is seen from a study of many specimens of *B. humilis* collected in the last half century, that *B. consolidaefolia* is merely a slender-leaved form of *B. humilis* and is in no way specifically distinct.

BIDENS CONNATA Muhl. ex Willd., Sp. Plant. **3**: 1718. 1804.

FERNALD (Rhodora **10**: 197. 1908) has given an excellent discussion of this species. Commonly it occurs with simple leaves and then is the var. *petiolata* (Nutt.) Farwell, but occasionally it possesses tripartite leaves, matching MUHLENBERG's original description of the species proper. In July 1913 it was my good fortune to be invited to accompany Dr. FERNALD from Cambridge, Mass., to Winchester, Mass., and there observe the tripartite leaves of the typical form, which grows in good quantity at that place. Tripartite leaves were present on young plants less than 3 dm. high. In the Central United States, however, tripartite leaves seem absent except on large, robust, well-developed specimens. FERNALD (*loc. cit.*) gives the range for the typical, tripartite-leaved form as extending from "Quebec to Massachusetts and Michigan and doubtless southward." This range is seen to be extended westward by the following specimens:

C. W. Duesner, Miller, Indiana, in 1908; *O. E. Lansing Jr.* 727, Roby, Indiana, September 16, 1899; *idem* 1179 Lake, Indiana, September 22, 1900; *idem* 2641, Roby, Indiana, September 20, 1906; *E. E. Sherff* 2016, Elgin, Illinois, September 12, 1915; *Dr. J. T. Stewart*, Peoria County, Illinois; *F. W. Johnson* 1123, Three Lakes, Wisconsin, August 24, 1914; *J. H. Schuette*, Green Bay, Wisconsin, August 30, 1881, and September 10, 1882; *idem*, Brown County, Wisconsin; *F. H. Burglehaus*, near Minneapolis, Minnesota, September 1892.

BIDENS FRONDOSA L. var. ANOMALA Porter ex Fernald, Rhodora **5**: 91. 1903.

This variety is peculiar in having upwardly barbed awns, but the precise significance of their occurrence is difficult at present to judge. In a specimen of the corresponding form of *B. connata* Muhl., the var. *anomala* Farwell, I have observed numerous downwardly barbed awns in the same heads with upwardly barbed awns (*Vasey*, near Georgetown, Washington, D.C., September 23, 1888, in U.S. Nat. Herb.). WIEGAND (Bull. Torr. Bot. Club **26**: 415. 1899) cites also similar material collected at Ithaca, New York. FERNALD (Rhodora **15**: 75. 1913) inclines toward regarding *B. frondosa* var. *anomala* as a geographic variety. He cites Pennsylvania, New Jersey, Delaware, also the region from Maine to Cape Breton Island for its distribution. It is interesting to note that out of many hundreds of specimens of *B. frondosa* that I have examined from Europe and America, there were observed only two instances of specimens of the var. *anomala* having been collected outside the range given by FERNALD. These plants, coming from Kansas and Nebraska, go further in showing the distribution to be very discontinuous.

E. Hall, Kansas, in 1869 (in U.S. Nat. Herb.); *P. A. Rydberg* 1707, Middle Loup River, near Thedford, Nebraska, August 26, 1893 (in Herb. Gray, etc.).

BIDENS ANGUSTISSIMA H.B.K., Nov. Gen. et Sp. **4**: 233. 1820.

The type of *B. angustissima* is matched very well by SCHULTZ BIPONTINUS' type of *B. linifolia* (both in Herb. Mus. Hist. Nat. Paris), except that the latter has only simple leaves, while the former has tripartite leaves. KLATT, in publishing the description of *B. linifolia* (Flora **68**: 203. 1885), described the heads as discoid. But that rays were present on at least the Paris material is shown by SCHULTZ BIPONTINUS' label, in his own handwriting, which reads, "achs. rad. calva . . . ." Furthermore, PRINGLE (no. 6924, granitic ledges at altitude of 2895 m., Cerro Ventoso above Pachuca, Hidalgo, Mexico, August 18, 1898) has collected many fine specimens of the simple-leaved form, and these all show orange-yellow rays, about 8 on each head. Thus the only difference to be found between the two species is the questionable one of foliage.

At Gray Herbarium there occurs a single sheet (*Coulter* 375, Mexico) with three slender but well-developed specimens; the largest one, at the left, matching the type of *B. angustissima*, and the other two, at the right, matching the type of *B. linifolia*. From these it appears safe to say that *B. linifolia* will be found, on future field study, to be merely a simple-leaved state of *B. angustissima*.

BIDENS REFRACTA Brandeg., Zoe **1**: 310. 1890.—*Bidens riparia* H.B.K. var. *refracta* O. E. Schulz, Urb. Symb. Antill. **7**: 132. 1911.

SCHULZ (*loc. cit.*) regarded this species as only a variety of *B. riparia* H.B.K., and he differentiates the two forms on the basis of fruit characters. But an examination of many specimens of each form shows that the only genuine difference is in the foliage. *B. refracta* has tripartite leaves, while *B. riparia* has bipinnate leaves. This difference SCHULZ seems to have overlooked. Indeed, he even refers to *B. refracta* a plant collected by *Tonduz* (no. 13618, several fine specimens of which are in U.S. Nat. Herb., Herb. Brit. Mus., etc.) that is identical in foliage and other parts with the type and *Bonpland* cotype of *B. riparia* (in Herb. Mus. Hist. Nat. Paris).

Of 22 collections of *B. refracta* studied so far, I have seen only one instance where the leaves were not of the tripartite kind. In this case (*Jenman* 5499, British Guiana, October 1889, in U.S. Nat. Herb.) the leaves are somewhat more divided, but still far from resembling those of true *B. riparia*. The probabilities are strong that *B. refracta* and *B. riparia* are entirely distinct species.

BIDENS SQUARROSA H.B.K., Nov. Gen. et Spec. **4**: 238. 1820.—*Bidens tereticaulis* DC., Prodr. **5**: 598. 1836; *Bidens antiguensis* Coult., BOT. GAZ. **16**: 100. 1891; *Bidens tereticaulis* DC. var. *antiguensis* O. E. Schulz, Urb. Symb. Antill. **7**: 142. 1911; *Bidens tereticaulis* DC. var. *sordida* Greenm., Proc. Amer. Acad. **39**: 115. 1903; *Bidens tereticaulis* DC. var *indivisa* Robins., Proc. Bost. Soc. Nat. Hist. **31**: 270. 1904; *Bidens Coreopsidis* DC. var. *procumbens* Donn. Sm., BOT. GAZ. **42**: 299. 1906.

DECANDOLLE (*loc. cit.*), in describing his *Bidens tereticaulis*, stated that it differed in having glabrate leaves, all of which were

trisected, in having heads smaller, and in coming from a different region ("Differt a *B. squarrosa* foliis glabriusculis . . . . capitulo minore, foliis etiam superis trisectis et patria"). But he had not seen the type material of *B. squarrosa*, as is evidenced by his failure to use the abbreviation "v.s." in connection with its description (*loc. cit.*, 599). At Paris (in Herb. Mus. Hist. Nat. Paris) is still preserved KUNTH's type of *B. squarrosa*. Upon the label are the words "*Bidens squarrosa* mihi . . . . Caracas." This is positively the specimen KUNTH had at hand in drawing up his description. It consists of a branchlet coming from a portion of a stem. The eaves of the branchlet are simple, as described by KUNTH. One well preserved leaf, still attached,[1] and certain similar but more fragmentary leaves, some of them broken loose, remain with the stem proper. These leaves are very important, as they establish definitely and beyond all question the identity of *B. squarrosa* with pubescent forms of *B. tereticaulis* DC., and not with *B. reptans* (L.) G. Don (with which it is equated by O. E. Schulz, *loc. cit.*, 140). This will become evident on reference to pl. IX, drawn directly from the type with the utmost fidelity to all details.

The presence of pubescence in this species is not of specific importance, a fact recognized by GREENMAN (*loc. cit.*) and by SCHULZ (*loc. cit.*, 142) when they treated very tomentose specimens as mere varieties of *B. tereticaulis*. Nor is the presence of several or even many undivided leaves of decisive value, a fact recognized by ROBINSON (*loc. cit.*) in treating as a variety of *B. tereticaulis* a specimen with all of its leaves simple. That COULTER (*loc. cit.*) treated his *B. antiguensis* (pl. X) as a distinct species[2] is easily explained by the fact that the strong superficial resemblance of his first type specimen's foliage to that of certain hispid forms of *B. leucantha* (L.) Willd., led him to contrast it with that species,

[1] At least when I examined it in 1914, as may be verified by a photograph taken by myself at that time and now deposited, with many hundreds of others of the genus *Bidens*, in the herbarium of Field Museum. The specimen was very brittle and certain parts were observed to crack even during my cautious handling of it.

[2] It may be noted that the Guatemalan form *B. antiguensis* has glabrous awns on its achenes. This character, which, however, is inconstant in some cases, is noticeable in nearly all the specimens of *B. squarrosa* from Central America. In South America and in Mexico the awns are almost always barbed.

from which he very properly regarded it as distinct. It is interesting to observe that COULTER also noted the remarkable variation in pubescence ("exceedingly variable in pubescence, from glabrous to pilose-pubescent").

B. Coreopsidis DC. var. *procumbens* Donn. Sm. is a form of this species. Its leaves are mainly 5-parted and are slightly narrower than in most specimens. It approaches rather closely *B. reptans* (L.) G. Don var. *bipartita* O. E. Schulz, of Porto Rico, but as a rule is quite distinct from that form.

Since *B. squarrosa* thus is found to be so highly variable, it is thought best to present here a rather full and representative list of specimens studied: *H. H. Rusby* 1642, at altitude of 609 m., Guanai, Bolivia, May 1886; Mig. Bang 1406, Guanai-Tipuani, Bolivia, April to June 1892; *Humboldt* and *Bonpland*, Caracas, Venezuela; *A. Fendler* 696, near Tovar, Venezuela, 1854–55; *H. H. Smith* 519, at altitude of 609 m., Jiracasaca, Santa Marta, Colombia, October 1898–1901; *C. Hoffmann* 383, Valley of the Rio Legardo, Costa Rica; *Ad. Tonduz* 12284, at altitude of 1800 m., forests of the Mala Via at Copey, Costa Rica, April 1898; *idem* 7265, banks of the Rio Maria Aguilar near San Jose, Costa Rica, December 29, 1892; *idem* 13600, in thickets, Nicoya, Costa Rica, January 1900; *idem* 7058, at altitude of 1100 m., San Francisco de Guadalupe, Prov. San Jose, Costa Rica, January 1896; *idem* 7248, in thickets upon banks of the Rio Torres near San Francisco de Guadalupe, Costa Rica, January 4, 1893; *Biolley* 7028, in copses near San Mateo, Costa Rica, January 18, 1892; *C. F. Baker* 2121, Dept. Leon, Nicaragua, January 17, 1903; *idem* 2214, Masaya, Dept. Masaya, Nicaragua, January 27, 1903; *H. Pittier* 1838, at altitude of 600 m., in hedges around Copan, Honduras, January 9, 1907; *Luis V. Velasco* 8873, San Salvador, Salvador, December 1905; *W. A. Kellerman* 5341, El Rancho, Sierro de las Minas Mountains, Baja Vera Paz, Guatemala, January 6, 1906; *idem* 5351, at altitude of 1205 m., Moran, Amatitlan, Guatemala, February 11, 1905; *idem* 6118, Volcano Acatenango, Chimaltenango, Guatemala, February 8, 1907; *idem* 8035, at altitude of 1067 m., El Rancho, Sierra de las Minas Mountains, Baja Vera Paz, Guatemala, January 1908; *Maxon* and *Hay* 3162, at altitude of about 550 m., vicinity of Secanquim, Alta Vera Paz, Guatemala, January 4, 1905; *John Donnell Smith* 2354, at altitude of 1778 m., Antigua, Sacatepequez, Guatemala, April 1890; *Heyde* and *Lux* 4193, at altitude of 1956 m., Buena Vista, Santa Rosa, Guatemala, December 1892; *E. W. D. Holway* 4, at altitude of 1778 m., Guatemala City, Dept. Guatemala, Guatemala, December 31, 1914; *idem* 110, at altitude of about 1778 m., Solola, Guatemala, January 25, 1915; *H. von Tuerckheim* 297, at altitude of 1565 m., Coban, Alta Vera Paz, Guatemala, May 1886; *idem* 7900, at altitude of 350 m., Cubilquite, Alta Vera Paz, Guatemala, January 1901; *Charles C. Deam* 109, at altitude of 49 m., Los Amates, Izabal, Guatemala,

February 12, 1905; *Enrique Th. Heyde* 666, Guatemala, in 1892; *Berlandier* 730 and 2150, Tantoyuca, Vera Cruz, Mexico, December 1830; *idem* 2148, Mexico; *Botteri* 489, Orizaba, Vera Cruz, Mexico; *Bourgeau* 1560, Valley of Cordoba, Vera Cruz, Mexico, October 12, 1865; *idem* 3093, Orizaba, Mexico, October 3, 1866; *C. Conzatti* 122, at altitude of 1200 m., Mountains of Oaxaca, Mexico, September 20, 1895; *idem* 1581, at altitude of 1800 m., Cerro San Antonio, Oaxaca, Mexico, October 28, 1906; *idem* 2269, at altitude of 2000 m., Cerro San Felipe (Distr. del Centro), Oaxaca, Mexico, October 18, 1908; *Conzatti* and *Gonzalez* 1133, at altitude of 850 m., Cordoba, Vera Cruz, Mexico, December 1900; *E. A. Goldman* 30, at altitude of 244 m., near Metlaltoyuca, Puebla, Mexico, January 27, 1898; *idem* 493, Apazote, Campeche, Mexico, December 28, 1900; *E. W. D. Holway* 3667, Oaxaca, Mexico, October 18, 1899; *E. Langlassé* 689, at altitude of 300 m., southern Mexico, December 2, 1898; *E. W. Nelson* 1508, at altitude of 1585–2075 m., Valley of Oaxaca, Oaxaca, Mexico, October 2, 1894; *idem* 1824, at altitude of 1600–1955 m., 9.6 km. above Dominguillo, Oaxaca, Mexico, October 30, 1894; *idem* 3410, near Yajalon, Chiapas, Mexico, November 21, 1895; *C. R. Orcutt* 3031, Sanborn, Vera Cruz, Mexico, April 18, 1910; *C. A. Purpus* 3633, Zacuapan, Vera Cruz, Mexico, October 1909; *Charles L. Smith* 298 and 633, at altitude of 1955–2135 m., Monte Alban, near City of Oaxaca, Oaxaca, Mexico, October 1894; *idem* 587, Coatzacoalcos, Vera Cruz, Mexico, February 6, 1895; *Lucius C. Smith*, at altitude of 2135 m., Rancho de Calderon, Oaxaca, Mexico, September 10, 1894.

Bidens Brandegeei, sp. nov.—Herba annua, erecta (nisi infra plus minusve arcuata), 3–5 dm. alta, maximam partem albido-hispida. Caulis quadrangulatus, striatus, ramis tenuibus ramosus. Folia opposita, petiolata, petiolo adjecto 1–8 cm. longa, pinnata aut bipinnata, supra minus albido-hispida; foliolis 3–5, ovatis (aut ovato-lanceolatis) serratisque et non dissimilibus iis *B. leucanthae* (L.) Willd., aut pinnati partitis, lobulis aut dentibus indurato-apiculatis; petiolis 0.2–2.5 cm. longis, basi connatis. Capitula pauca, terminalia, ligulata, tenuiter pedunculata, pedunculis monocephalicis, 3–8 cm. longis. Involucri squamis subaequalibus duplici serie dispositis; exterioribus (circ. 8) linearibus, 1-nervatis, apiculatis, albido-ciliatis et-hispidis, 4–5 mm. longis; interioribus lanceolatis, membranaceis, glabratis aut pubescentibus, margine diaphanis. Ligulae (circ. 5) obovatae, in specimine sicco albido-flavae, 7–9-striatae, ad apicem obscure dentatae, 1–1.3 cm. longae. Paleae lineares, margine diaphanae, 3–4 mm. longae. Achaenia (submatura) attenuato-linearia, striata, exaristata, supra antrorsum hispida, 4–6 mm. longa.

T. S. Brandegee, in vicinity of San Luis Tultitlanapa, Puebla, near the Oaxaca boundary line, Mexico, in 1908 (first type sheet in Herb. Univ. Cal., herb. no. 134267, and second type sheet, dated July, also in Herb. Univ. Cal., herb. no. 134268); *C. A. Purpus* 4429 (in vicinity of San Luis Tultitlanapa, Puebla), Oaxaca, Mexico, August 1908.

A species having at times all the leaves tripartite and then deceivingly like *B. leucantha* (L.) Willd. except as to achenes. The description is drawn mainly from the two flowering specimens on the first type sheet, but the achene characters are described from the single fruiting head present on the second type sheet. The species is here named for T. S. BRANDEGEE, who himself has described several species of *Bidens*, and who by his collections and writings has extended our knowledge of this genus to a considerable extent.

Recently, Dr. SIDNEY F. BLAKE has sent from Gray Herbarium a specimen of *Bidens* that appeared to him as allied with *Bidens rubifolia* H.B.K., but none the less new. The plant was collected by HOLWAY in Guatemala early in the present year, and is described by him as "climbing over trees 40–50 feet and then dropping down nearly to the ground." Its heads, in antithesis, measure about 6 cm. in diameter. From *B. rubifolia* it may easily be recognized in herbarium specimens by its large involucre and the unique characters of the involucral bracts. A detailed description is presented here:

Bidens Holwayi Sherff and Blake, sp. nov.—Herba scandens, caule demum 20–30 m. longo, ascendente (ex HOLWAYO) in altitudinem 12–15 m.; ramis tetragonis, glabris, striatis. Folia opposita, petiolata, petiolo adjecto 6–18 cm. longa, tripartita aut summa indivisa, ciliata, supra glabrata (nisi ad venas), infra plus minusve piloso-hispida, serrata; foliolis lateralibus ovatis aut ovato-lanceolatis, terminali ovato-lanceolato aut lanceolato. Petioli 1.5–4cm. longi, basi connati et hispido-ciliati. Capitula magna, ligulata, pedunculata pedunculis (in uno specimine observato) 12–13 cm. longis. Involucrum ad basim dense piloso–tomentosum, squamis longis duplici serie dispositis; exterioribus 8 (aut 9) late linearibus, hispido-ciliatis, subsparsim hispidis, 9–15 mm. longis; interioribus, saepe paulo brevioribus, anguste lanceolatis, ad faciem exteriorem piloso-tomentosis, marginibus diaphanis. Ligulae (5, aut interdum verisimiliter etiam 6 aut 7) lineari-ellipticae, flavae, 9–11-striatae, 2.3–3 cm. longae, ad apicem irregulariter 2–4-dentatae aut lobulatae. Paleae lineares, demum 1.2–1.5 cm. longae, marginibus

diaphanis. Achaenia linearia, subplana, nigra, ciliata, ad facies sparsim hispida, ± 1.3 cm. longa, ad apicem nonnullis erectis setis coronata, biaristata aristis retrorsum hamosis et divaricantibus.

E. W. D. Holway 816, Quezaltenango, Guatemala, January 31, 1917 (type in Herb. Gray).

BIDENS SAMBUCIFOLIA Cav. Icon et Descript. 3:15. *pl. 229.* 1794; *Bidens alamosana* Rose, Contrib. U.S. Nat. Herb. 1:104 *pl. 6.* 1891.

A comparison of the type illustration of *Bidens alamosana* with that of *B. sambucifolia* reveals a remarkable similarity. Furthermore, the descriptions of the two species are very close and differ materially only in that the ligules of *B. sambucifolia* are described as scarlet; those of *B. alamosana* are yellow or orange-yellow.

CAVANILLES' description was based upon material from the Royal Garden at Madrid and which was stated by him to have come originally from Peru and Mexico. It may well be that his citation of Peru was entirely erroneous, as I have never been able to find a specimen from elsewhere than Mexico. An examination of numerous specimens collected in Mexico shows the ligules to be usually yellow or orange-yellow, but in certain rare cases the ligules (in the dried specimens) have a color so reddish as to explain quite plausibly how Cavanilles was led to call them scarlet ("corolla . . . . coccinea"). Thus, for example, a specimen by *T. S. Brandegee*, collected at Culiacan, Sinaloa, Mexico, September 12, 1904 (in Herb. Univ. California), has one flowering head with a distinct reddish shade to its orange ligules. The other two flowering heads present on the same sheet have yellow-orange ligules. Clearly, CAVANILLES and ROSE were dealing with the same species, and the name *Bidens sambucifolia*, antedating *B. alamosana* by nearly a century, must be used hereafter for this species.

UNIVERSITY OF CHICAGO

SHERFF on BIDENS

SHERFF on BIDENS

EXPLANATION OF PLATES IX AND X

PLATE IX

Bidens squarrosa H.B.K.: *a*, fruiting spray ×0.75; *b*, exterior bract ×3; *c*, interior bract ×3; *d*, ligulate floret ×3; *e*, palea ×4.5; *f*, disk floret ×4.5; *g*, achene ×4.5; all from type in Herb. Mus. Hist. Nat. Paris.

PLATE X

Bidens squarrosa H.B.K. (*B. antiguensis* Coult.): *a*, portion of branch ×0.7; a^1 and *k*, small portions of 2 plants showing comparative pubescence ×0.7; *b* and *l*, exterior bracts ×4; *c* and *m*, interior bracts ×4; *d* and *n*, ligulate florets ×4; *e*, palea ×4; *f* and *o*, disk florets ×4; *g*, anthers ×35; *h*, pollen grain ×1000; *i*, style branches ×20; *j*, achene ×6; *a-j* from first type sheet and *k-o* from second type sheet of *Bidens antiguensis* (both *J. D. Smith* 2354 in Herb. Univ. Chicago).

EFFECT OF SOME ALKALI SALTS UPON FIRE-HOLDING CAPACITY OF TOBACCO

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY 233

HENRY R. KRAYBILL

Introduction

Of all the qualities which are essential in a good cigar tobacco no single one is quite so important as the burn. The general composition of the leaf and the salts which it contains exert a great influence upon the course of the combustion. It is a well established fact that chlorides tend to prevent complete combustion and thereby products are formed which are injurious to the flavor and aroma. On the other hand, the carbonates of the alkalies, particularly of potassium, aid the combustion and increase the fire-holding capacity.

The term "burning qualities" with reference to a cigar is general and includes many points. The most important of these points are evenness of burn, color of ash, firmness and coherence of the ash, and the fire-holding capacity. The fire-holding capacity refers to the length of time the leaf or cigar will continue to glow after ignition. A cigar tobacco must have primarily a good fire-holding capacity, and for this reason this has been the main criterion in judging the burn of cigar tobacco.

Historical

It was maintained early that the fire-holding capacity depended upon the content of nitrates. SCHLOSING (15) and later others have disproved this theory. SCHLOSING (15), NESSLER (12, 13), KISSLING (8), and VAN BEMMELN (17) have shown that in a good burning sample of tobacco potassium is present in excess of the amount equivalent to combine with the sulphuric and hydrochloric acids, while in a poor burning sample it is equal to this amount or less. This indicates that potassium salts of organic acids favor a good burn. GARNER (4) concludes that the fire-holding capacity is

dependent primarily upon the content of potassium combined with organic acids.

NESSLER (12) concluded that potassium sulphate exerts a favorable influence upon the burn; while JENKINS (6) found that fertilizing with potassium sulphate increased the content of sulphuric acid in the tobacco so that in some cases it injured the burn. GARNER (4) concluded that sulphates in general are injurious to the burning qualities, but not to so great an extent when all of the sulphuric acid is combined with the potash; while PATTERSON (14) found no apparent relation of the content of sulphuric acid to the burn.

NESSLER (12, 13), KISSLING (7), BEHRENS (2), VAN BEMMELN (17), BARTH (1), PATTERSON (14), CARPENTER (3), and GARNER (4) agree that chlorides are injurious to the burn. KISSLING (8) considered the content of ash to have little influence upon the burning qualities; while PATTERSON (14) and CARPENTER (3) concluded that a high content of ash was conducive to a good burn. NESSLER (12) found that calcium and magnesium have little effect except to whiten the ash. KISSLING (7) found good burning samples of tobacco high in content of calcium and fairly high in magnesium. GARNER (4) concluded that calcium in general does not greatly affect the fire-holding capacity, but is essential in the production of a good ash, and that large amounts of magnesium injure the burn. BARTH (1) treated several kinds of paper with numerous salts and found that tri-potassium phosphate is injurious to the burn. GARNER (4) found di-potassium phosphate neutral in its effects upon the burn.

A consideration of the reason for the favorable action of the potassium salts of organic acids has led to several theories. SCHLOSING (15) attributes their favorable action to the fact that when heated they swell and yield a porous mass. NESSLER (12) says that the potassium salts are reduced and that potassium acts as an oxygen carrier; while GARNER (4) attributes their action to the fact that the salts are readily decomposed to yield carbonates. GARNER suggests that the carbonates may act favorably by alternately giving off and taking up carbon dioxide, or that small amounts of free potassium may be formed which may act as an

oxygen carrier. MAYER (10) also attributes the beneficial effects of the alkali salts to the fact that they are easily reduced. BARTH (1) suggests that the salts may have a beneficial action by raising the temperature of the leaf; he also attributes the harmful effect of the chlorides to the fact that they fuse and coat over the material, thereby preventing complete combustion.

Object

The object of this work is to study the effects of various salts closely related to the salts of potassium with a view to obtaining some light upon the conflicting theories. It has been suggested that the effect of the various salts upon the colloidal state of the material of the leaf may bear some relation to the problem. It was thought that probably potassium possesses some peculiar chemical properties which may account for its action.

Effect of salts upon combustion of tobacco

METHOD

The method of experimentation consisted of treating leaves and filter paper with various salts and noting their effect upon the fire-holding capacity. The samples of tobacco used in this work were of a single strain of a cigar filler type of tobacco grown in Pennsylvania under definite fertilizer treatments. The leaves previously had been well sweated. In all cases the solutions of the salts applied were 28.9 per cent normal. In order to see whether the effect of the salts was upon the colloidal state of the materials of the leaf, some of the leaves were rendered acid by treatment with 0.5 normal acetic acid, and others were rendered alkaline by a treatment with 0.2 normal solution of sodium hydroxide. The salts were applied by means of an atomizer, and then the leaves were placed under a bell jar to allow the salts to diffuse throughout the leaf. Knowing that different portions of the same leaf have different fire-holding capacities, in each test a portion of the tip, middle, and base of the leaf were used, and similar portions were saved for a check upon each leaf. The strip of leaf was ignited by means of a fishtail burner and the time of holding fire was determined by means of a stop watch. As would be

expected, due to variations in different leaves, the results were not always consistent in some cases where the comparative differences were small, but in each case a number of tests were carried out upon a number of different leaves until the average results were considered reliable for the purpose of comparing the effects of the various salts.

DATA

Because of the similarity in chemical behavior of the alkalies caesium, rubidium, potassium, sodium, and lithium, it was thought that a comparison of the effects of their salts upon the fire-

TABLE I

LEAVES FROM PLATS FERTILIZED WITH MANURE ONLY

Salt treatment	Other treatment	Number of tests	Average number of seconds holds fire	Average number of seconds increases fire-holding capacity
Rb_2CO_3	0.2/N NaOH	50	71	60
K_2CO_3	"	60	40	24
Na_2CO_3	"	60	18	5
Li_2CO_3	"	50	19	4
Rb_2CO_3	0.5/N acetic acid	10	59	45
K_2CO_3	"	60	44	35
Na_2CO_3	"	60	18	10
Li_2CO_3	"	50	19	13
Rb_2CO_3	Nothing	90	101	88
K_2CO_3	"	90	68	43
Na_2CO_3	"	60	34	11
Li_2CO_3	"	20	20	12

holding capacity of tobacco might throw some light upon the problem under consideration. The data obtained are indicated in the accompanying tables. The rubidium carbonate and caesium carbonate used were tested spectroscopically.

Tables I and II show that caesium, rubidium, and potassium carbonates greatly promote the fire-holding capacity of tobacco. Rubidium carbonate is always more effective than potassium, and in the case where the three salts were compared upon the same kind of leaves caesium carbonate was more effective than rubidium. The relative behavior of sodium and lithium suggests the possibility that their effect upon the precipitation of colloids may enter in as

a minor factor. According to HÖBER (5), the relative effectiveness of the alkalies in precipitating colloids in an acid medium is as follows: lithium > sodium > potassium > rubidium > caesium. In an alkaline medium the order is as follows: caesium > rubidium > potassium > sodium > lithium. In the cases where lithium is more

TABLE II

LEAVES FROM PLATS FERTILIZED WITH POTASSIUM CHLORIDE

Salt treatment	Other treatment	Number of tests	Average number of seconds holds fire	Average number of seconds increases fire-holding capacity
K_2CO_3	0.2/N NaOH	60	54	49
Na_2CO_3	"	60	21	14
Li_2CO_3	"	60	16	10
K_2CO_3	0.5/N acetic acid	20	27	24
Na_2CO_3	"	20	8	5
Li_2CO_3	"	20	9	6
Cs_2CO_3	Nothing	20	61	57
K_2CO_3	"	30	40	36
Rb_2CO_3	"	20	48	44

TABLE III

LEAVES FROM PLATS FERTILIZED WITH MANURE ALONE

Salt treatment	Other treatment	Number of tests	Average number of seconds holds fire	Average number of seconds increases fire-holding capacity
Potassium oxalate	0.2/N NaOH	70	42	19
Sodium oxalate	"	70	19	−3
Lithium oxalate	"	70	14	−6
Potassium oxalate	0.5/N acetic acid	100	33	21
Sodium oxalate	"	100	11	0
Lithium oxalate	"	100	14	2
Potassium oxalate	Nothing	50	37	21
Sodium oxalate	"	50	16	1
Lithium oxalate	"	50	13	−2

effective than sodium in the precipitation of colloids, it is also more effective in promoting the fire-holding capacity, and vice versa. Potassium, rubidium, and caesium, however, do not show this relation. This casts some doubt upon this principle of the behavior of sodium and lithium. At any rate, this effect upon the colloidal state of the materials of the leaf could be of only

minor importance. It seems very evident that of all the alkali carbonates only those of caesium, rubidium, and potassium materially aid the fire-holding capacity.

Table III shows that of the oxalates of potassium, lithium, and sodium, only the oxalate of potassium is effective in increasing

TABLE IV

LEAVES FROM PLATS FERTILIZED WITH MANURE ALONE

Salt treatment	Other treatment	Number of tests	Average number of seconds holds fire	Average number of seconds increases fire-holding capacity
Potassium citrate	0.2/N NaOH	30	29	13
Sodium citrate	"	20	15	4
Lithium citrate	"	20	16	6
Potassium citrate	0.5/N acetic acid	20	39	19
Sodium citrate	"	20	18	1
Lithium citrate	"	20	19	1
Potassium citrate	Nothing	20	24	18
Sodium citrate	"	20	10	4
Lithium citrate	"	20	11	5

TABLE V

LEAVES FROM PLATS FERTILIZED WITH POTASSIUM CHLORIDE

Salt treatment	Other treatment	Number of tests	Average number of seconds holds fire	Average number of seconds increases fire-holding capacity
Potassium citrate	0.2/N NaOH	50	28	18
Sodium citrate	"	50	11	2
Lithium citrate	"	50	10	0
Potassium citrate	0.5/N acetic acid	20	37	30
Sodium citrate	"	20	10	3
Lithium citrate	"	20	5	−2

the fire-holding capacity. Here again in the cases where lithium is more effective than sodium in the precipitation of colloids, it is slightly more effective in promoting the fire-holding capacity.

From tables IV and V we see that potassium citrate is the only one of the 3 citrates which materially aids the burn. No correlation can be seen here between the effects of the salts upon the precipitation of colloids and their effect in increasing the fire-holding capacity.

Table VI shows a comparison of the results of a number of potassium salts. All of the potassium salts are very effective in promoting the fire-holding capacity, with the exception of the chloride, acid sulphate, and mono-potassium phosphate, which

TABLE VI

LEAVES FROM PLATS FERTILIZED WITH MANURE ALONE

Salt treatment	Number of tests	Average number of seconds holds fire	Average number of seconds increases fire-holding capacity
K_2CO_3	90	68	43
KCl	50	9	− 7
$KHSO_4$	40	7	−14
K_3PO_4	40	37	14
KH_2PO_4	40	16	−13
K_2HPO_4	40	42	13
K_2SO_4	30	53	29
Potassium oxalate	50	37	21
Potassium citrate	20	24	18
Potassium tartrate	50	64	48
Potassium acetate	50	45	29

TABLE VII

LEAVES FROM PLATS FERTILIZED WITH MANURE ALONE; LEAVES TREATED WITH 0.2/N NaOH, AND THEN WITH SALTS

Salt treatment	Number of tests	Average number of seconds holds fire	Average number of seconds increases fire-holding capacity
Na_2CO_3	60	18	5
NaCl	50	5	−1
$NaNO_3$	30	11	2
Na_2SO_4	20	6	1
Na_3PO_4	40	25	3
Na_2HPO_4	40	27	3
Sodium oxalate	70	19	−3
Sodium citrate	20	15	4
Sodium acetate	30	16	−5
Sodium tartrate	40	18	−5

are very injurious. Potassium carbonate and those salts which yield potassium carbonate when burned, tri-potassium phosphate, di-potassium phosphate, and potassium sulphate, improve the fire-holding capacity.

Table VII shows that sodium carbonate is the most effective of all of the sodium salts in promoting the burn. The other salts

are either nearly neutral or exert a harmful effect. It is quite evident that none of the sodium salts exert the marked beneficial effects which some of the potassium salts exert.

Effect of salts upon combustion of lump sugar

The effect of various salts of the alkalies upon the combustion of different kinds of paper and lump sugar was also studied; although, as one would expect, due to the dissimilarity of materials, the results in these cases were not always parallel with those upon tobacco. The results with lump sugar are particularly interesting. In each case a small portion of the salt was placed upon the lump of sugar and then an attempt was made to burn the sugar by touching it to a gas flame. The results obtained are indicated in table VIII.

Discussion

SCHLOSING (15) attributed the favorable action of the organic salts of potassium to the fact that they swell up and yield a porous mass. NESSLER (12) combated this idea and showed that other salts of potassium which do not swell so much when heated also have a favorable action in promoting the fire-holding capacity of tobacco. GARNER showed that the carbonates of potassium are just as effective as the organic salts. From tables VI and VII we see that both potassium sulphate and tri-potassium phosphate, as well as potassium carbonate, promote the fire-holding capacity. These results confirm the conclusions of NESSLER and GARNER, and indicate that the good effects of the potassium salts of organic acids cannot be attributed to the fact that they swell and yield a porous mass when heated.

NESSLER (12) suggests that potassium salts are reduced and that small amounts of elemental potassium may act as an oxygen carrier. It is true that the salts of potassium which have a favorable action upon the fire-holding capacity are all salts of acids which are in a highly oxidized condition. Although no direct data could be found which would show the relative ease of reduction of the alkali carbonates, there are data upon the electrolytic solution tension of the alkalies. The order of the alkalies according to their decreasing electrolytic solution tension is as follows: caesium, rubidium, potassium, sodium, and lithium. The same order

represents their increasing ease of reduction in solution. If we assume that this represents the order of the ease of reduction of the

TABLE VIII

EFFECT OF SALTS UPON THE COMBUSTION OF LUMP SUGAR

Salt	Effect
K_2C_3O	Lump of sugar burned with flame; sugar coaled
Rb_2CO_3	" " " " " " " "
Cs_2CO_3	" " " " " " " "
Na_2CO_3	" " " " " " " "
Li_2CO_3	" " " " " " " "
K_2SO_4	Lump of sugar burned slightly; sugar coaled slightly
K_2HPO_4	Lump of sugar burned; sugar coaled
KH_2PO_4	Lump of sugar burned slightly; sugar coaled slightly
K_3PO_4	Lump of sugar burned with flame; sugar coaled
KCl	" " " " " " " "
KNO_3	Lump of sugar burned with flame, sputtered; sugar coaled
Potassium acetate	Lump of sugar burned with flame; sugar coaled
Potassium citrate	" " " " " " " "
Potassium oxalate	" " " " " " " "
Potassium tartrate	" " " " " " " "
LiCl	" " " " " " " "
Lithium oxalate	" " " " " " " "
Lithium citrate	" " " " " " " "
NaCl	Lump of sugar burned slightly; sugar coaled
Sodium tartrate	Lump of sugar burned with flame; sugar coaled
Sodium oxalate	" " " " " " " "
Without salt	Lump of sugar melted, would not burn; did not coal
$LiSO_4$	Sugar melted; did not burn with flame; did not coal
Na_2SO_4	Lump of sugar burned slightly; sugar coaled slightly
$CaCO_3$	Sugar melted; did not burn with flame; did not coal
Pb_3O_4	Lump of sugar burned with flame; sugar coaled
$BaCO_3$	" " " " " " " "
$KMnO_4$	" " " " " " " "
Fine metallic iron	Lump of sugar burned with difficulty
Platinized asbestos	" " " " " "
Zinc filings	" " " " " "
Copper filings	" " " " " "
Finely powdered glass tubing	Lump of sugar burned with flame; sugar coaled
Finely powdered charcoal	Lump of sugar burned with flame
Carbonized sugar	" " " " " "

alkali carbonates, it would be difficult to explain by NESSLER'S theory why lithium and sodium carbonates are not effective, and caesium, rubidium, and potassium carbonates are effective.

GARNER (4) suggests that the carbonate might act favorably by alternately giving up and taking on carbon dioxide. We have seen that caesium, rubidium, and potassium carbonates are very much more effective than the carbonates of sodium and lithium. At 700° C. the order of the alkali carbonates according to their increasing ease of dissociation is as follows: potassium, rubidium, sodium, caesium, and lithium. Lithium carbonate is dissociated into carbon dioxide and lithium oxide to a much greater degree at 700° C. than any of the other carbonates (9). If potassium carbonate acts favorably by alternately giving off and taking up carbon dioxide, it is difficult to see why lithium carbonate should not be even more effective. It seems, therefore, that this theory will not explain the beneficial action of the caesium, potassium, and rubidium carbonates.

From table VIII we see that all of the salts which were effective in increasing the fire-holding capacity of tobacco will cause the lump of sugar to burn with a flame when ignited by means of a gas burner. Some of the salts which were only slightly effective in increasing the fire-holding capacity of tobacco, such as lithium carbonate and sodium carbonate, are effective also in promoting the combustion of sugar with the production of a flame. Here again caesium, potassium, and rubidium carbonates are particularly active. BARTH (1) has suggested that the salts present in the leaf may aid in the combustion by raising the temperature of the leaf, the effect being somewhat analogous to the effect of salts upon raising the boiling point of water. As shown in table VIII, such substances as metallic filings, powdered glass, and carbonized sugar when used in larger quantities also are effective in causing the lump of sugar to burn. From these results obtained upon lump sugar, it would seem as though their effect in raising the temperature might be of significance. But with this theory alone it would be difficult to account for the differences in degree of action of the various salts. Also it would be difficult to explain why some of the salts have no effect, while others have a very

marked effect in promoting the combustion of tobacco. SLIGH and KRAYBILL (16) have determined the temperatures of burning cigars and have found some evidence which suggests that the moisture content as well as the composition of the cigar has an effect upon the burning temperature. It is planned to study this problem further with the object of determining the extent to which this hypothesis may be applied.

BARTH (1) considers the harmful effect of chlorides to be due to the fact that they fuse and coat over the material, thereby preventing complete combustion. SLIGH and KRAYBILL (16) found the temperature in the cigar varying from 813° C. to 925° C. during a puff, and from 584° C. to 803° C. at stationary temperatures between the puffs. It is doubtful whether the temperature of the burning strip of a leaf of tobacco would be as high as these stationary temperatures of the cigar. The temperature of the leaf then would not be high enough to fuse pure sodium chloride or pure potassium chloride. It would seem then as though the theory of BARTH would not account for the harmful effect of the chlorides. An objection might be raised from the standpoint that we have in the leaf mixtures of salts, and that their fusing points would be lower than that of the pure salts. The fusing point of sodium chloride is about 820° C., and that of rubidium carbonate is 837° C. (9). It would be difficult to understand why one salt should harm the burn by fusing and the other should not harm the burn when they fuse at almost the same temperature.

An attempt was made to tabulate and compare the chemical and physical properties of these salts with the hope of finding some explanation of their action. Among the properties compared were the melting points, specific heats, speed of vaporization, and dissociation pressure of the carbonates. A very careful comparison of the chemical and physical properties of the salts does not seem to offer any explanation of their action. It is true that the order of effectiveness of the caesium, rubidium, and potassium carbonates is the same as their increasing electrolytic solution tension, and also the same as their increasing atomic weights. The question might be raised as to whether their behavior might

not be due in part to the alkalinity of the salts in solution. Such an explanation, however, would not account for the behavior of the sodium and lithium carbonates.

Extremely small amounts of caesium, potassium, or rubidium carbonates greatly increase the fire-holding capacity of the tobacco. A 2 per cent solution of potassium carbonate applied by means of an atomizer to the leaf was sufficient to produce the effect. Upon examining the ash left after the combustion, the potassium was found as the carbonate, that is, in the same form in which it was present before the combustion. It is possible, therefore, that certain salts, such as the carbonate, phosphate, and sulphate of potassium, and the carbonates of rubidium and caesium, act in a catalytic manner to promote the combustion of the tobacco leaf. In the combustion of lump sugar other salts are also effective, but the carbonates of caesium, potassium, and rubidium are more effective. Here the effect of the salts in raising the temperature may be important.

According to this assumption, caesium carbonate, potassium carbonate, rubidium carbonate, tri-potassium phosphate, di-potassium phosphate, and potassium sulphate have a catalytic action favoring the combustion of the tobacco leaf. The salts of sodium and lithium, potassium chloride, mono-potassium phosphate, and acid potassium sulphate do not have this catalytic action. The harmful effects of the chlorides seem to be due to a negative catalytic action.

It is possible that a careful study of the chemical action resulting when various organic materials, such as filter paper, and sugar treated with the salts, are subjected to temperatures close to the temperature of the burning cigar may help to explain the action. NEF (11) has studied the effect of alkalies upon the oxidation of sugars in solution at low temperatures. It may be that a study of the rate of oxidation of various organic salts of the alkalies when subjected to high temperature may furnish a better explanation of the effect of the potassium salts. Studies along these lines are planned. It may be that more than one factor plays a rôle in determining the action of the various salts, resulting in a complex situation.

Summary

1. The alkali carbonates of caesium, rubidium, and potassium have a definite marked effect in promoting the fire-holding capacity of tobacco, which sodium and lithium carbonates do not exhibit, the order of effectiveness being as follows: caesium, rubidium, potassium.

2. Of the oxalates tried, only potassium is effective. In the case of the carbonates and the oxalates in an alkaline medium, where lithium is more effective than sodium in the precipitation of colloids, it is slightly more effective also in promoting the fire-holding capacity. In the case of the citrates there is no such relation and, in the case of the carbonates, potassium, rubidium, and caesium do not behave in this manner. It is doubtful, therefore, whether the effect of the salts upon the colloidal state of the tobacco leaf is of any significance.

3. Only potassium citrate is effective in promoting the burn. The citrates of sodium and lithium are nearly neutral in their effect.

4. The organic salts of potassium, potassium carbonate, tri-potassium phosphate, di-potassium phosphate, and potassium sulphate improve the fire-holding capacity; while potassium chloride, acid potassium sulphate, and mono-potassium phosphate are injurious to the burn.

5. Sodium carbonate improves the fire-holding capacity slightly, while all of the other sodium salts are either neutral or injurious to the burn.

6. The data obtained do not confirm the idea that the reduction of the potassium salts will account for their favorable action.

7. Data are given which indicate that the harmful action of chlorides is not due to the fact that they fuse, as was suggested by BARTH.

8. Data are given which indicate that the alternately giving off and taking up of carbon dioxide will not account for the beneficial effects of potassium carbonate.

9. The effect of the salts in raising the temperature of the leaf may be of some significance.

10. The problem is probably complex, and the action of the caesium, potassium, and rubidium salts may be due to a number of complex factors.

11. It seems probable that caesium, potassium, and rubidium in the form of certain salts, such as the carbonates, sulphates, and phosphates, have a specific catalytic action in the combustion, and that the chlorides have a negative catalytic action. It is planned to study the rate of decomposition of various organic salts of the alkalies, and also the decomposition products of various organic substances treated with salts of the alkalies, when subjected to temperatures which are attained in the burning cigar.

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NOTES ON NEW OR RARE SPECIES OF RAVENELIA

W. H. Long

While on recent field work in Texas, the writer collected several very interesting species of *Ravenelia*. Some of them are undescribed, while others have heretofore been known only from their type collections. Several of them are Mexican, while one is a South American species.

Ravenelia hoffmanseggiae, sp. nov.

O. Pycnia unknown.

II. Uredinia amphigenous, scattered, orbicular to irregularly oval, liver brown,[1] subepidermal, ruptured epidermis prominent; paraphyses none; urediniospores obovate, ellipsoid to subglobose, 16–25 by 25–30 μ, average for 10 spores 19.7 by 26.7 μ, walls thin, 1–1.5 μ, uniform in thickness and concolorous, capucine buff in color, sparsely and minutely echinulate when dry but appearing as if smooth when wet; germ pores 8, situated in two irregular rows of 4 each, one row subequatorial, the other near apex of spore, in the subglobose spores the germ pores appear as if scattered.

III. Telia unknown.

On Cassiaceae. Type collected on *Hoffmanseggia oxycarpa* at Del Rio, Texas, November 6, 1916, by *W. H. Long* (no. 6082).[2] This is the first collection of *Ravenelia* to be reported on this host, although the genus *Hoffmanseggia* is widely distributed throughout those regions where species of *Ravenelia* flourish.

Ravenelia siderocarpi, sp. nov.

O. Pycnia unknown.

II. Uredinia amphigenous but mainly epiphyllous, scattered, bullate to oval, 0.1–0.8 mm. across, often in a circle around a central sorus, chestnut-brown, subcuticular, long covered by the cuticle, ruptured cuticle very prominent; paraphyses none;

[1] Ridgway, Robert, Color standards and color nomenclature. pp. 43. *pls.* 53. Washington, D.C. 1912.

[2] Unless otherwise stated, all herbarium numbers cited in this article refer to the herbarium numbers of the writer.

urediniospores obovate, obovate-elliptical to subpyriform, 15–18 by 25–37 μ, average for 20 spores 16.9 by 31.7 μ, walls ochraceous-tawny, concolorous, thick, 2.5–3.5 μ, apex but slightly if at all thickened, echinulate; germ pores prominent, 6 in equator.

III. Telia amphigenous, usually epiphyllous, sparse, scattered, small, 0.1–0.5 mm. across, bullate to elliptical, subcuticular, blackish-brown, tardily naked, ruptured cuticle very conspicuous; paraphyses none; teliospore heads chestnut-brown, subglobose, 40–60 μ in diameter, average for 20 heads 50.5 μ, 2–4 spores across, 5–10 spores to each head, 4–8 marginal, 0–3 inner spores, usual number of spores per head 7–8, each spore bearing 3–6 short hyaline tubercles 3–5 μ long; cysts few, 4–8, as many as the marginal spores, subglobose, subpendant around pedicel, not cohering, easily swelling and bursting in water; pedicel hyaline, short, deciduous, compound.

On Mimosaceae. Type collected on *Siderocarpos flexicaulis* 6 miles from Brownsville, near Tandy's Switch, Texas, November 11, 1916, by *W. H. Long* (no. 6174). This *Ravenelia* is very abundant on this host in the Texas ebony jungles in the immediate vicinity of Brownsville. It is probably common wherever its host is found in sufficient quantity to form thickets.

Ravenelia prosopidis, sp. nov.

O. Pycnia unknown.

II. Uredinia sparse in material examined, small, amphigenous, mainly epiphyllous, often in a circle around a central sorus, 0.5–1.0 mm. across, narrowly elliptical to oval, subepidermal, long covered by the epidermis, ruptured epidermis very prominent; urediniospores oval to subpyriform, 13–20 by 24–41 μ, strontium yellow, average for 40 spores, 16.9 by 31.6 μ; walls 1.5–2 μ thick, apex slightly darker and thicker, verrucose-echinulate, germ pores 4–6 in equator; paraphyses abundant, of two types, the usual form capitate, the other broadly clavate, in a dense ring around the sorus, also intermixed with the spores, heads of capitate paraphyses madder brown, walls thickened at apex, stipe amber yellow to hyaline, solid, 12–27 by 28–85 μ, average for 40, 16.84 by 55.5 μ, clavate paraphyses 10–13 by 25–45 μ, average for 10, 13.6 by 39 μ.

III. Telia amphigenous, mainly hypophyllous, Vandyke brown, usually in a circle around a central sorus, 0.5–1.0 mm. across,

elliptical to oval, subepidermal, early naked, ruptured epidermis very prominent; teliospore-heads tawny, depressed hemispherical, often concave at top, 75–118 μ, average for 40 heads 94 μ, 6–10 spores across, 20–28 marginal spores, 16–40 inner spores, usual number for head 46–54 spores in all; heads papillate, with one, rarely two, papillae to each spore, papillae ranging from mere tubercles near top of head to blunt papillae 4–7 μ long around margin, top of heads often free from papillae, many heads with only a few tubercles on entire head, papillae light brown; paraphyses very abundant in a dense circle around the telia, also scattered throughout the sorus, similar to those found in the uredinia, often sori occur which are composed mainly of paraphyses; cysts numerous, pendant in 2 or 3 rows around the pedicel, subglobose, about as many as marginal spores, easily swelling and bursting in water; pedicel compound, deciduous, hyaline to faintly fulvous, short.

On Mimosaceae. Type collected on *Prosopis juliflora* at Denton, Texas, October 10, 1907, by *W. H. Long* (no. 2013); also collected on same host and in same locality in 1908 by *Long* (no. 4870). A part of the type material of this *Ravenelia* was issued in *Fungi Columbiani*, E. BARTHOLOMEW, no. 2681, as *Ravenelia arizonica* Ellis and Ev.

Ravenelia prosopidis is closely related to *R. arizonica*, but differs from this species in the very irregular length of its papillae and in having some teliospore heads nearly smooth. Its telia are also encircled by a dense layer of paraphyses, while none or but very few paraphyses are found in the telia of *R. arizonica*. This species will probably be found throughout northern Texas within the range of its host. It is sometimes associated on the same leaves with *Neoravenelia holwayi*, at least some telia were found which contained teliospores with heads entirely smooth, while other and adjacent sori contained the typical papillate heads of *R. prosopidis*.

RAVENELIA ROEMERIANAE Long

O. Pycnia sparingly present, amphigenous and fruticolous, in orbicular groups of 6–20, groups 0.5–1.0 mm. across, usually surrounded by a circle of uredinia, blackish-brown, flattened hemispherical, 70–105 μ across, 25–38 μ tall.

II. Uredinia usually fruticolous but also amphigenous, occasionally caulicolous and in very rare cases forming slight witches'

brooms, often densely confluent on both sides of the pods over areas 1–5 cm. across, individual uredinia on pods elliptical to irregularly oval, 0.2–0.6 mm. across, verona brown to tawny-olive in color, uredinia on leaves amphigenous, elliptical to irregularly oval, primary uredinia often encircling pycnia; urediniospores obovate-oblong to linear-oblong, on pods 10–17 by 27–45 μ, average for 20 spores 13 by 31 μ, on leaves urediniospores are 10–14 by 27–38, average for 20 spores 13 by 33 μ, average for both sets of spores 13 by 32 μ; walls 1–1.5 μ thick, slightly thicker above (about 3 μ), prominently but sparsely echinulate, spinules very sparse on upper third of spore, upper third golden brown to wine color, remainder of spore paler to hyaline, germ pores 8, in 2 rows of 4 each, upper row at boundary of colored and hyaline part of spore, lower row about the same distance below the equator; paraphyses abundant, intermixed with the urediniospores, clavate to clavate-capitate, 35–50 μ long, average length for 10, 44.0 μ, heads 9–13 μ, average for 10 heads 10 μ, apex of head thickened about 3 μ, pale fulvous, stipe usually thin-walled, hyaline.

III. Telia amphigenous, often abundant on all parts of badly infected leaves, scattered, subcuticular, blackish, shining, 0.2–1.2 mm. across, irregularly oval, ruptured cuticle noticeable; teliospore heads blackish, 63–100 μ, average for 30 heads 78 μ, 5–7 cells across, 14–30 spores in each head, 8–14 marginal spores and 6–15 inner ones, verrucose, each spore bearing 3–10 colorless warts about 2 μ tall by 3 μ broad; paraphyses present and similar to those in uredinia; cysts of same number as marginal spores, flattened, appressed beneath head, extending from periphery to pedicel, in one row, united laterally, ovoid to oblong-ovate, slow to burst in water; pedicel short, colorless, compound, deciduous.

DISTRIBUTION.—TEXAS: On *Acacia roemeriana*, San Marcos (type locality), *Long*, in November 1915 (nos. 5494 and 5498 type), in May 1916 (nos. 6009, 6019, 6020, and 6065); San Antonio, *Long*, in May 1916 (nos. 5610, 5611, 5612, 5614, and 5615), and in November 1916 (nos. 6155 and 6159); Uvalde, *Heald* and *Wolf*, in August 1909 (no. 6243); *Long*, in November 1916 (nos. 6145 and 6148).

The type of *Ravenelia roemerianae* was collected on *Acacia roemeriana* at San Marcos, Texas, in November 1915, but on account of the lateness of the season this material did not contain any uredinia. In May 1916, the writer

visited the type locality of this rust at San Marcos and found an abundance of uredinia, especially on the pods. Some uredinia as well as pycnia were also found on the leaves. Even at that early date telia were developing and the uredinia on the leaves were disappearing. The uredinia which were so abundant on the pods in May weathered and disappeared so that none were found on the pods in November of the same year.

The writer has seen several thousand trees of *Acacia roemeriana* infected with this *Ravenelia* in various places in Texas, and only two trees of this entire number showed any evidence of witches' brooms. One tree was found at San Antonio and the other at Uvalde, Texas. There were some 10–15 witches' brooms on each of these two trees. Apparently the germination of the teliospores of this rust occurs when the pods are young and easily infected and yet not at the right season to infect the young branches and cause witches' brooms.

This rust is closely related to *Ravenelia versatilis* (Peck) Dietel, a fact noted in a previous article[3] by the writer. Table I gives a brief comparison of the more salient characters of each of these two species of *Ravenelia*. From this table the main differences between the two species are easily seen.

Ravenelia roemerianae has been collected by the writer in several places in Texas and probably occurs wherever the host is present. The rust was exceedingly abundant in the vicinity of Uvalde, Texas, in November 1916. Every tree of *Acacia roemeriana* examined by the writer in the mesquite (*Prosopis juliflora*)-catclaw (*Acacia roemeriana*) flats was heavily infected; in fact every leaf on most of the trees was practically covered with the blackish telia of this rust.

RAVENELIA MESILLANA Ellis and Barth. Bull. Torr. Bot. Club **25**:508. 1898

(*Ravenelia longiana* Sydow. Hedwigia Beibl. **40**:128. 1901)

O. Pycnia, appearing before the uredinia, sparse, amphigenous, in circinating, crowded, orbicular groups 2–4 mm. across, subcuticular, Brussels brown, depressed hemispherical, 40–60 μ tall by 100–165 μ broad.

II. Uredinia amphigenous, mainly hypophyllous, scattered, tawny, oval to elliptical, 0.5–1.0 mm. in diameter, early naked, pulverulent, subcuticular, ruptured cuticle very noticeable; urediniospores oval to subglobose, 15–22 by 20–26 μ, average for 20 spores 19 by 23 μ; walls 2–3 μ thick, tawny-olive, sparsely echinulate, germ pores 6–8, scattered; paraphyses very few, intermixed with

[3] LONG, W. H., Five undescribed species of *Ravenelia*. BOT. GAZ. **61**:416–424. 1916.

TABLE I

Species	Uredinia	Urediniospores	Paraphyses	Telia heads	Cysts
Ravenelia roemerianae	Usually on pods	10–17×27–45 μ, average for 40 spores 13×32 μ	6–13×32–54 μ, average 11×43 μ	63–100 μ, average 78 μ, marginal spores 8–14, inner spores 6–15, usual number per head 20–26, 5–7 across, heads verrucose	Flattened, appressed, in 1 row
Ravenelia versatilis. . .	Usually on leaves and young twigs, forms witches' brooms	9–16×16–27 μ, average for 40 spores 12×23 μ	8–16×27–57 μ, average 12×38 μ	53–90 μ, average 71.6 μ, marginal spores 5–18, inner spores 3–20, usual number per head 34–36, 5–7 cells across, heads smooth	Flattened, appressed, in 1 row

the spores, colorless, clavate to subcapitate, 5–14 by 35–62 μ, average for 20, 9.6 by 45 μ, apex of head thin-walled, base of head very thick-walled, stipe usually solid.

III. Telia amphigenous, scattered, 0.5–1.0 mm. across, often confluent over areas 3–4 mm. in diameter, brownish-black, elliptical to irregularly oval, subcuticular, ruptured cuticle very conspicuous; teliospore heads dark chestnut-brown, hemispherical, smooth or an occasional head with a few scattered, short (2–3 μ), hyaline, tubercles, especially on the marginal spores, 5–9 cells across, 60–90 μ, average for 20 heads 74 μ, 10–20 marginal spores, 8–24 inner spores, usual number per head 24–32; paraphyses present but very few and similar in every way to those found in the uredinia; cysts hyaline, in 2–3 rows around the pedicel, many, not coherent with each other, slow to burst in water, subpendant; pedicel colorless, compound, short, deciduous.

This description of the rust was drawn from material on *Cassia roemeriana*.

DISTRIBUTION.—NEW MEXICO: On *Cassia bauhinioides*, Mesilla Park, *Wooton*, in October 1895, ex. Herb. N.Y. Bot. Garden (no. 5021 *Long*) and ex. Herb. A. and M. College of N. Mex. (no. 5022 *Long*); *Wooton* in October 1897, *North American Fungi*, Herb. of ELAM BARTHOLOMEW (part of type material, no. 5025 *Long*); mesa west of Organ Mountains, *F. C. Werkenthin*, in October 1916 (no. 5480 *Long*); TEXAS: On *Cassia roemeriana*, Austin, November 1897 (no. 5039), type material for *Ravenelia longiana*, *Long*, in August 1901 and October 1915 (nos. 1019 and 5481); Llano, *Heald* and *Wolf*, August 1909 (no. 1751 Herb. Path. and Myc. Investigat., Plant Disease Survey); Marble Falls, *Carsner* and *Studhalter*, May 1912 (no. 4333 Herb. Univ. Texas); Meridian, *Long*, June 1916 (no. 6056); San Antonio, *Long*, May and November 1916 (nos. 5616 and 6168); San Marcos, *Long*, November 1915, and May 1916 (nos. 5468 and 6034).

This *Ravenelia* was first collected on *Cassia bauhinioides* at Mesilla Park, New Mexico, in 1895 and again in 1897 by WOOTON. It was described as a new species by ELLIS and BARTHOLOMEW from the New Mexico material collected in 1897. It has been reported on this host only from the type locality. In 1900, the writer sent SYDOW a *Ravenelia* on *Cassia roemeriana*, collected at Austin, Texas, in 1897. From this material he described as new, *Ravenelia longiana*.

In recent investigations on the genus *Ravenelia*, the writer's attention was called, not only to the marked resemblance of *R. mesillana* to *R. longiana*, but also to the close relationship of the two host plants, *Cassia bauhinioides* and *C. roemeriana*. The only appreciable difference heretofore reported between the two rusts was the supposed fact that *Ravenelia mesillana* had no paraphyses,

while *R. longiana* had a few hyaline ones. The writer has material from the type collections of both of these species, and a careful examination of this material shows that not only do both species have paraphyses, but that the paraphyses are identical in every respect and are present in the telia of the type material of both *R. mesillana* and *R. longiana*. A careful study of the other salient characters of these rusts has convinced the writer that they are identical in every respect and therefore should be considered as only one species.

In recent field work in Texas, the writer collected the pycnidial stage on *Cassia roemeriana* of what has heretofore been known as *Ravenelia longiana*.

Ravenelia siliquae Long

O. Pycnia unknown.

II. Uredinia hypophyllous and caulicolous, on the leaves scattered, elliptical, 0.5–1.0 mm. across, pulverulent, subcuticular, early naked, sudan brown, ruptured cuticle not prominent, uredinia on the woody twigs and branches perennial, very inconspicuous, elliptical, 0.5–5 mm. long by 0.5–2 mm. broad; urediniospores obovate, elliptical to rarely oblong, on the leaves 13–17 by 20–27 μ, average for 10 spores 14.4 by 21 μ, urediniospores on branches 11–16 by 17–27 μ, average for 20 spores 13.4 by 22.5 μ, urediniospores on both leaves and branches buff yellow; walls 1.5–2.5 μ thick, concolorous, not thickened at apex, densely and strongly verrucose, germ pores 8, in two transverse zones of four each, equidistant from the equator; paraphyses abundant, intermixed with the spores, clavate to subcapitate, often curved, 7–10 by 50–67 μ, average for 10 paraphyses 9.5 by 62 μ, heads pale fulvous to hyaline, stipe slender, usually solid, hyaline, paraphyses in sori on woody branches few, 6–11 by 25–49 μ, average for 20 paraphyses 8.3 by 38 μ.

III. Telia unknown.

On Mimosaceae: Distributed as follows: Texas, on *Acacia farnesiana*, San Antonio, *Long*, November 1916 (no. 6153); *W. H. Mercer*, February 1917 (no. 6263); Mexico, on *Acacia farnesiana*, Etla, Oaxaca, *Holway*, October 1899, no. 3841 of *Holway* (type); Hawaii, on *Acacia farnesiana*, Honolulu, *Harold L. Lyon*, January 1913, no. 164, Sydow, *Fungi exotici exsiccati*.

The rust on the pods of this host from Hawaii agrees very closely with the Mexican type material. There are a few minor differences in the characters of this rust when on leaves and stems and when on the pods, but they are not sufficient in the judgment of the writer to constitute a new species. From the foregoing distribution it is seen that since this *Ravenelia* was described in 1903

on the pods of *Acacia farnesiana* from Mexico, the rust has been collected in Texas on the leaves and woody branches of this host and in Hawaii on the pods. It was probably introduced into Hawaii on nursery stock which contained infected woody branches. Apparently *Ravenelia siliquae* does not have a telial stage, since only uredinia have ever been found, although this rust has been collected during October, November, January, and February on pods, leaves, and woody branches, and in three countries, namely, United States, Mexico, and Hawaii.

Ravenelia australis Diet. and Neg.

O. Pycnia unknown.

II. Uredinia amphigenous, very small, punctiform to irregularly oval, less than 0.5 mm. across, subepidermal, soon naked, ruptured epidermis inconspicuous; urediniospores obovate, elliptic-obovate to subpyriform, light cinnamon brown, 13–20 by 25–32 μ, average for 20 spores 16.6 by 28.2 μ; walls 1.5–2.0 μ thick, slightly or not at all thickened above, concolorous, echinulate, germ pores 4–6, equatorial; paraphyses very abundant, incurved, dense, encircling the sori, ferruginous, hyphoid, more or less curved near apex, 10–17 by 50–67 μ, average for 10 paraphyses 12.5 by 14.4 μ, walls about 2.5 μ thick, an occasional paraphysis clavate, nearly colorless and with a solid stipe.

III. Telia amphigenous, punctiform to irregularly oval, less than 0.5 mm. across, blackish-brown, subepidermal, early naked, ruptured epidermis inconspicuous; paraphyses very abundant, encircling the sori and similar to those found in the uredinia; teliospore heads chestnut-brown, hemispherical, 67–110 μ across, average for 20 heads 92.3 μ, 7–11 cells across, 18–30 marginal spores, 22–64 inner ones, 40–94 spores per head, smooth; cysts small, numerous, subglobose, subappressed, beneath entire head, in two rows, swelling and easily bursting in water; pedicel short, hyaline, deciduous.

On Mimosaceae.—The following collections were made by the writer in Texas, all on *Acacia farnesiana:* Uvalde, November 1916 (nos. 6150, 6151, and 6152); San Antonio, November 1916 (no. 6165). The above is a description of rust as it occurs in Texas.

This species of *Ravenelia* has heretofore been known only from its type locality in South America (Concepcion, Chile), where it was found on *Acacia cavenia*, now recognized as a synonym for *A. farnesiana* (*Vachellia farnesiana*).

The writer has not been able to obtain authentic material of this South American *Ravenelia*, nevertheless he is assigning to this species the Texas *Ravenelia* collected on the same host (*A. farnesiana*), since its characters are practically identical with those described for the South American plant.

RAVENELIA GRACILIS Arth.

O. Pycnia not found in the Texas material.

II. Uredinia epiphyllous, seated on slightly pallid areas, scattered, very small, less than 0.4 mm. across, elliptical to irregularly oval, tardily naked, subepidermal, ruptured epidermis prominent; urediniospores ovate, ovate-fusiform to somewhat flask-shaped, usual shape ovate-flask-shaped, 15–21 by 30–45 μ, average for 20 spores 18.4 by 37.6 μ; walls 2–2.5 μ thick, russet colored, sparingly echinulate, apex darker and slightly thickened, germ pores 4–6, in equator; paraphyses few, peripheral and also intermixed with the spores, hyphoid to subclavate, hyaline, walls thin, 4–7 by 35–50 μ.

III. Telia epiphyllous, similar in size and shape to the uredinia, blackish-brown, subepidermal; teliospore heads dark chestnut-brown, hemispherical, 60–87 by 37–40 μ thick, average for 20 heads 73.8 by 39 μ, 5–6 spores across, 8–14 marginal spores, 4–12 inner spores, usual number per head 22–24, each spore on lower part of head bearing 2–4 small, hyaline tubercles, 2–5 μ long, upper portion smooth, or with 1–4 very short tubercles to each spore; cysts in 1 row, subglobose, few, as many as the marginal spores, united laterally and extending from periphery to stipe, subappressed, easily swelling and bursting in water; pedicel short, deciduous, colorless.

Collected on *Havardia brevifolia*[4] 6 miles from Brownsville, Texas, near Tandy's Switch, November 10, 1916, by *W. H. Long* (no. 6160). This description was made from material collected at Brownsville, Texas.

This rust has heretofore been known only from the type collection which was made at San Luis Potosi, Cardenos, Mexico, on an unknown host. The writer recently collected at Brownsville, Texas, what appears to be the same species. A careful comparison of the type material collected by HOLWAY in Mexico with the Brownsville rust shows no essential characters sufficient to warrant making a new species of the Texas *Ravenelia*. A study of the Mexican

[4] The writer is under obligations to Dr. J. K. SMALL, of the New York Botanical Garden, for identifying this host and the host of *Ravenelia hoffmanseggiae*.

host and of the host found at Brownsville shows that the two are apparently identical. *Ravenelia gracilis* was rather common in the vicinity of Brownsville wherever the host occurred in any quantity. In the original description of this species the urediniospores are given as obovate and the teliospore heads as bearing 4–7 colorless tubercles to each spore. The writer, however, failed to find any obovate urediniospores in that portion of the type collection which is in his herbarium. The teliospore heads of the type show many heads with smooth tops but with short tubercles around the margin, while other heads in the same mount have shorter and fewer warts to each spore at the top than on the margin, thus agreeing in every detail with the Brownsville material.

Ravenelia leucaenae Long

This species was collected by the writer near Brownsville, Texas, on *Leucaena pulverulenta*. There are certain minor characters of this rust not given in the published description of it that are worth recording. The urediniospores on this host are mainly concolorous, often with the apex slightly thickened. The teliospore heads are 5–6 cells across, with 5–16 marginal spores and 3–14 inner ones, usual size 14–16 spores per head, each spore at top of head bears from 0 to 2–4 very short tubercles, while there are 4–6 straight or slightly curved tubercles, 4–6 μ long, on each marginal spore; cysts as many as marginal spores, appressed, extending from periphery to pedicel.

This *Ravenelia* has been reported from Mexico on the following host species: *Leucaena* sp., *L. diversifolia*, and *L. esculenta*.

Neoravenelia holwayi (Dietel) Long

II. Uredinia caulicolous, forming large, woody, perennial, fusiform galls, 1–8 cm. thick by 4–12 cm. long, densely confluent over large areas on the galls, subepidermal, argus brown; urediniospores oblong-linear, obovate, elliptical, clavate to subpyriform, usual shape obovate to subclavate, 13–24 by 26–53 μ, average for 120 spores 17 by 36 μ; walls 2–3 μ thick, slightly thickened above, sudan brown, often lighter to subhyaline below the equator, echinulate, germ pores 4–6 in equator; paraphyses few capitate or sometimes clavate-capitate, 13–22 by 30–65 μ, average for 10 paraphyses 17.6 by 46.3 μ, heads intensely colored, deep chestnut-brown to liver brown, nearly solid, stipe hyaline or faintly tinted.

III. Teliospores intermixed in uredinia on the galls; teliospore heads liver brown, hemispherical, often depressed, smooth, 60–130 μ, average for 40 heads 103 μ, 8–12 spores across, 20–38 marginal spores, 40–78 inner ones, average number of spores in each head 84–94; cysts globose to subglobose, in 2–3 rows, pendant beneath entire head, not coherent, slow to burst in water; pedicel hyaline or slightly tinted, short, deciduous, compound. This is a description of the gall-producing form of *Neoravenelia holwayi*.

For several years the writer has been finding a species of *Ravenelia* on mesquite (*Prosopis juliflora*) which produces large, fusiform, woody galls. At first this rust was referred to *Ravenelia arizonica*, but a careful examination of the galls revealed the presence of teliospores with smooth heads. These smooth teliospores were so constantly found associated with certain types of galls that the writer made a special study of the galls found on mesquite. This investigation showed that there was a *Ravenelia* present on galls throughout a certain zone which constantly produced smooth teliospore heads. A careful study of the *Ravenelia* on these galls failed to show any positive differences either in the urediniospores or teliospores which would separate this gall-forming species from the ordinary leaf form of *Neoravenelia holwayi*. There are wide variations in shape and size of the urediniospores, as is to be expected when growing on galls as compared to those found on the leaves.

The galls were found in localities where the leaves of the mesquite were abundantly infected with the usual form of *N. holwayi*. In the vicinity of San Antonio and Uvalde the galls were rare, but at Corpus Christi and Brownsville they were rather common. From Del Rio west to New Mexico and Arizona all of the galls found on the mesquite were of a different type and were associated with the teliospores of *Ravenelia arizonica*. The galls produced by *Neoravenelia holwayi* are smoother and more fusiform than those caused by *Ravenelia arizonica*. In *R. arizonica* the galls are rather brittle, due to the large amount of parenchyma tissue developed in the gall. On weathering, even when alive these galls have deep transverse fissures in their surfaces. The galls produced by *Neoravenelia holwayi* are very woody, rather smooth, do not develop many fissures, but form round wartlike knobs on the older galls, on which are borne the urediniospores and teliospores. But few sori of any kind were found on galls collected as late as November. The surface of the galls where the sori once were borne had healed over, except here and there a sorus was left which contained both urediniospores and teliospores.

The writer is placing this gall-producing form provisionally under *Neoravenelia holwayi*, since at the present time no evidence is at hand sufficient to justify separating this gall form from the typical *N. holwayi*. Further investigation and study of this rust may show that its aecial stage is not of the *Caeoma* type as is *N. holwayi*, in which case it would belong to the genus *Ravenelia* and

would be an undescribed species. As it now stands, this species parallels *Ravenelia arizonica*, both species having a leaf and a gall form; the galls of each usually bear only urediniospores, while teliospores are rarely found on the galls but usually occur on the leaves.

Type material of each of the 3 new species of *Ravenelia* described in this paper has been deposited in the Pathological and Mycological Collections of the Bureau of Plant Industry, Department of Agriculture, Washington, D.C.

Office of Investigations in
Forest Pathology
Bureau of Plant Industry
Albuquerque, N.M.

ARBORES FRUTICESQUE CHINENSES NOVI. III[1]

CAMILLO SCHNEIDER

Cotoneaster (Sect. CHAENOPETALUM Koeh.) **oligocarpa,** n.sp.—Frutex latus, erectus, ad 4 m. altus; ramuli hornotini initio tomento villosulo flavescenti-cinereo adpresso obtecti, annotini satis glabrescentes, fusco-rubri, vetustiores glabri, plus minusve cinerascentes. Folia subcoriacea, partim persistentia, ovalia, obovato-elliptica vel praesertim versus apicem ramulorum ovata (in specimine florenti distinctius obovata), apice acuta et mucronulata vel satis obtusa et interdum subrotundata, basi pleraque late cuneata, 2.5–5 cm. longa et 1.2–2.5 cm. lata, superne saturate, sed ut videtur obscure, viridia, initio laxe villosula, biennia costa impressa excepta glabra, subtus modo ramulorum novellorum dense tomentosa, etiam adulta haud vel tantum in costa elevata paullo glabrescentia, in facie sub microscopio papillis distinctis non praedita, nervis lateralibus superne plus minusve impressis subtus satis prominentibus utrinsecus 8–12; petioli dense tomentosi, vix ultra 6 mm. longi; stipulae triangulari-lanceolatae, acuminatae, petiolis breviores, subtus dense tomentosae, superne glabriores. Corymbus satis densus, multiflorus, ad 4 cm. (vel ultra?) latus et ad 3.5 cm. altus, villosus, bracteis bracteolisque deciduis subulatis circ. 3 mm. longis; pedicelli 1–3 mm. longi, ut pedunculi villosi; flores albi; receptaculum ovato-turbinatum ut sepala late triangularia circ. 1–1.5 mm. longa apice glanduloso-mucronulata intus glabra satis dense tomentosulum, ad 2.5 mm. longum;

[1] Through an unfortunate coincidence, three of the species of *Mahonia* proposed by me in the previous paper (BOT. GAZ. **63**: 519–521. 1917) have been described by TAKEDA in his "Contributions to the knowledge of the Old World species of the genus *Mahonia*" (Not. Roy. Bot. Gard. Edinburgh, nos. 29, 30. January 1917). I had no knowledge of this publication until it was too late to change the names in my paper.

M. caesia Schn. is apparently the same as *M. bracteolata* Takeda, of which I have not yet seen the type or the figure, TAKEDA's being not yet published. *M. nivea* Schn. becomes a synonym of *M. hypoleuca* Takeda; and TAKEDA is the first author of *M. philippinensis*. HENRY's no. 10309, cited by me under *M. Alexandri* Schn., is referred by TAKEDA to his new *M. lomariifolia*, of which I have cotypes before me. I do not believe that the two species are the same, the shape and color of the leaflets being, in my opinion, too different.

petala orbicularia, circ. 2.5 mm. lata, basi unguiculata, intus pilosula; stamina 20, petalis paullo breviora, antheris ut videtur violaceis; carpidia 2, apice sparse villosa, stylis quam stamina fere longioribus stigmatibus capitatis planis. Fructus parvi, rubri, subglabri vel satis villosuli, plus minusve turbinati, 4–5 mm. longi, apice circ. 3 mm. crassi, sepalis extus villosulis incumbentibus fere clausi; pyrenia 2, obcordato-ovoidea, circ. 3.5 mm. longa et infra medium 2.5–3 mm. lata, stylum in apice vel paullo infra gerentia, ventre leviter carinata, subnitentia, dorso paullo sulcata, basi hypostylii leviter constricta, hypostylio circ. trientem dorsi occupante villosulo.

Yunnan boreali-occidentalis: in dumetis ad vias inter Ho-ching et Li-chiang-fu, alt. circ. 2600 m., 25 Septembris 1914, *C. Schneider* (no. 3070; typus in Herb. Arb. Arn. et Hb. Schneider).—Szechuan australis: ad vias in declivibus montium prope Wo-lo-ho, alt. circ. 2800 m., 13 Junii 1914, *C. Schneider* (no. 1408; foliis pro parte distinctius obovatis).

Judging by its very small fruits, this species is closely related to *C. salicifolia* Fr. which, however, may easily be distinguished by its more lanceolate and more acuminate leaves, which are more deeply furrowed and rugulose above and more glabrescent on the strongly prominent midrib and veins beneath, by its almost glabrescent fruiting inflorescences, and by the glabrous larger hypostyle. *C. salicifolia* var. *rugosa* R. and W. and var. *floccosa* R. and W. differ by the same characters of the leaves and by their larger more subglobose fruits. Its nearest relative may be *C. Harrowiana* Wils., of which I have not yet seen the fruit; but the old leaves of this species are much more glabrescent beneath. Having introduced *C. oligocarpa* into cultivation, it has to be decided by observation of living plants whether it is a good species or only a variety of *C. Harrowiana* which comes from southern Yunnan. *C. salicifolia* and its varieties, *C. Harrowiana* and *C. oligocarpa*, certainly form a group of very closely related species which may be distinguished from *C. Henryana* R. and W. and its allies by their leaves bearing no distinct papillae on the under surface, while on the leaves of *C. Henryana* the papillae are very distinct under the microscope.

Cotoneaster (Sect. CHAENOPETALUM Koeh.) **Vernae,** n.sp.—Frutex erectus, elongato-ramosus, altitudine incerto; ramuli hornotini dense cinereo- vel subflavescenti-villosulo-tomentelli, annotini plus minusve glabrescentes, fusco-rubri. Folia partim persistentia, subcoriacea, elliptico-oblonga, apice obtusa vel rotundata, basi acute vel obtuse cuneata, 2–3.5 cm. longa, 0.8–1.5 cm. lata, superne saturate viridia, subnitentia, etiam novella

tantum in costa impressa pilosa, facie plana sed tenuissime reticulata nervis non incisis, subtus dense ut ramuli tomentosa, etiam biennia tantum in costa prominente paullo glabrescentia, nervis lateralibus utrinsecus 5–7 vix vel paullo prominulis; petioli vix ad 5 mm. longi, dense tomentelli; stipulae anguste triangulari-lanceolatae, acuminatae, petiolis breviores, subglabriores. Corymbus pluriflorus, ad 3 cm. latus et 2.5 cm. longus, dense villoso-tomentosus; pedicelli 1–2 mm. longi, ut pedunculi tomentelli, bracteis bracteolisque deciduis; flores ignoti; fructus parvi, obscure rubri, turbinati vel globoso-turbinati, circ. 4 mm. longi et 3 mm. crassi, plus minusve villosuli, apice sepalis incumbentibus extus villosis fere clausi; pyrenia 2, circ. 3 mm. longa et 2.5 mm. lata, obovoidea, ventre plana, satis laevia, nitidula, dorso leviter rugulosa, stylum apice gerentia, hypostylio circ. trientem dorsi occupante villosulo.

Yunnan boreali-occidentalis: ad latera orientalia montium niveorum prope Lichiang-fu, alt. circ. 3000–3200 m., Octobri 1914, *C. Schneider* (no. 2676; typus in Herb. Arb. Arn. et Hb. Schneider).

The fruits of this species are extremely like those of *C. oligocarpa* Schn., previously described, but in its narrow elliptic obtuse leaves, which are smooth above and show very little prominent veins beneath, *C. Vernae* differs widely from all the species mentioned above. It seems to be more closely related to *C. pannosa* Fr. which, however, can easily be distinguished by its more ovate acute or shortly acuminate leaves, and by its larger fruits, the sepals of which are more erect. I am unable to identify my no. 2676 with any Chinese species hitherto described. I introduced it into cultivation (seed no. 578), and observations of living plants may give further indications of the real relationship of this apparently well marked species. It is named for my daughter Verna.

PRUNUS LATIDENTATA Koeh., var. **trichostoma,** n.var.—*P. trichostoma* Koehne in Sargent, Pl. Wils. 1: 216. 1912.—A typo non nisi sepalis intus et stylis basi distinctius pilosis differre videtur.

Szechuan australis: in regione Yen-yüan Hsien, inter viculos Ka-la-pa et Liu-ku, in sepibus, alt. circ. 3200 m., 17 Maji 1914, *C. Schneider* (no. 1210; frutex ad 2 m. altus); inter viculos Hun-ka et Wo-lo-ho, alt. circ. 3300 m., 13 Junii 1914, *C. Schneider* (no. 3520; arbuscula vel arbor ad 6 m. alta).

According to KOEHNE'S own statement, there is really no other difference between *P. latidentata* and *P. trichostoma* than the pubescence inside the sepals. So far as I can judge by the specimens before me, this character seems to be not sufficient to separate these two species. In my specimens the branchlets and pedicels are a little more hairy, and it seems to me rather difficult to decide to which of KOEHNE'S types the two numbers of mine are to be referred.

POTENTILLA ERIOCARPA Wall., var. **cathayana,** var. nov.—? *P. eriocarpa* Franchet, Pl. Delav. 211. 1889, non Wall., sensu Lehmann et Wolf; Diels in Not. Bot. Gard. Edinbgh. **7**: 157. 1912, 387. 1913.—A typo a cl. Lehmanno depicto recedit foliolis omnibus sessilibus, inflorescentiis ad 3-floris, sepalis externis ovato-lanceolatis subacuminatis quam interna paullo latiora saepe distinctius acuminata vix vel paullo brevioribus.

Yunnan boreali-occidentalis: in fauce infra glaciem parvam montium niveorum prope Lichiang-fu, in rupestribus calcareis, alt. circ. 3000 m., 17 Augustii 1914, *C. Schneider* (no. 2274; typus in Herb. Arn. Arb. et Hb. Schneider; suffrutex floribus magnis luteis, ramulis floriferis 5–15 cm. altis).

According to the figure given by LEHMANN and to WOLF'S description, the typical *P. eriocarpa* Wall. has "sepala externa late elliptica obtusa vel rotundata," and the leaflets are described as "plus minusve longe petiolulata (saltem terminale)." The petals of var. *cathayana* seem also to be much more emarginate than those of the type.

Rubus (Subgen. IDAEOBATUS Focke, sect. IDAEANTHI Focke) **testaceus,** n.sp.—Frutex habitu *R. Idaei* ad 1.5 m. altus, dumeta formans; rami vetustiores teretes, aculeis paucis aculeolis sparsis vel crebris rectis armati, satis dense villosuli et glanduloso-setulosi, setulis intermixtis, partim glabrescentes et testacei; ramuli floriferi ut videtur nondum satis evoluti ad 10 cm. longi, cum petiolis pedicellisque densius griseo-villosuli et etiam glanduliferi et parce setulosi. Folia visa omnia ternata; foliola ovato-rhomboidea vel rhomboideo-orbicularia, iis *R. schizostyli* ex icone a cl. Focke in monogr. p. 206 dato satis similia, terminalia petiolo ad 1 cm. longo suffulta, maxima visa ad 3.5 cm. longa et 3 cm. lata, apice rotundata, obtusa (vel rarius in foliolis satis juvenilibus oblongioribus subacuta), lateralia subsessilia, ad 1.8 cm. longa et 1.5 cm. lata, omnia subaequaliter satis grosse dentata vel inaequaliter dentato-serrata, sublobulata, superne satis flavo-viridia, laxe vel initio densius subadpresse hirto-pilosa et glandulosa, subtus vix discoloria, facie glabriuscula, in costa nervisque lateralibus utrinsecus (3–) 4 (–5) hirta et plus minusve glandulosa; petioli ad 2 cm. longi; stipulae lineares ad 6 mm. longae, praesertim extus villosae et glanduliferae. Flores axillis foliorum ex parte quasi ad bracteas reductorum singuli, apice ramulorum floriferorum pseudoracemas ad 6-(vel pluri-?) floras formantes, rubri, iis *R. triphylli* similes, circ. 1.5 cm. diametientes; pedicelli ad 15 mm. longi, medio saepe

bractea stipulis simillima instructi; calyx externe modo pedicellorum villosulus, glanduliferus et parcissime setulosus, sepalis lanceolatis acuminatis margine albo-villosis circ. 7 mm. longis patentibus intus basi glabrioribus; petala oblonga vel satis anguste obovato-oblonga, versus apicem acutiusculam undulato-marginata, basim versus longe cuneata, intus sparse pilosa, demum ut videtur patentia, sepalis subaequilonga et ultra medium circ. 3–3.5 cm. lata; stamina in flore ut videtur erecto-patentia, circ. 70–75, filamentis glabris longioribus petalis subaequilongis; carpophorum pilosum; carpidia circ. 30, 4.5–5 mm. longa, stylis glabris, ovariis ima basi pilosis et dorso pilis parcis praeditis; discus glaber. Fructus ignoti.

Szechuan australis: in regione Yen-yüan Hsien, inter viculos Ka-la-pa et Liu-ku, alt. circ. 3500 m., 17 Maji 1914, *C. Schneider* (no. 1269; frutex ad 1.4 m. altus, dumeta formans, foliis valde juvenilibus); eodem regione, ad viam inter Liu-ku et Kua-pie, alt. circ. 2800 m., 19 Maji 1914, *C. Schneider* (no. 1213; flores rubri).—Yunnan boreali-occidentalis: in regione Yung-ning, versus pagum Mu-ti-chin, alt. circ. 2800 m., 23 Junii 1914, *C. Schneider* (no. 3894; typus in Herb. Arb. Arn. et Hb. Schneider).

Judging by the shape of the leaves, this species seems to be very similar to *R. schizostylus* Lév., which I know only from the figure given by FOCKE in his Mon. Gen. Rubi Prodr. in Bibl. Bot. **72**: 206. *fig. 83*. 1911; but according to the description of the author this Corean species differs widely in having "rami rubescentes glabri . . . . foliola . . . . subtus cinerea . . . . pilis adpressis albis." *R. mesogaeus* Focke, l.c. 204. *fig. 82*, which is found in Hupeh and Szechuan, has white or pink flowers, and is otherwise extremely different. Another species to which *R. testaceus* may be related is *R. kanayamensis* Lév. and Van. in Bull. Soc. Bot. France **53**: 549. 1906 et apud Focke, l.c. 205, from Japan, of which the leaves are described as "in utraque pagina viridia et parce pilosa," but it has an "inflorescentia laxe effusa," and, according to FOCKE's statement, "revocat *R. id.* subspec. *strigosum*," the shape of the leaves of which is entirely different. The specific name of the new species refers to the pale brick red color of the older glabrescent branches.

ROSA MAIREI Lév., var. **plurijuga,** n.var.—A typo praecipue recedit foliis 5–6-jugis, foliolis etiam superne plus minusve dense villosulis.—Fructus plantae typicae incogniti, in varietate magni, rubri, ad 15 mm. crassi et 18 mm. longi (sepalis persistentibus exclusis), obovato-globosi, praesertim ad apicem tomentelli, ceterum glabri, basi subsensim in pedicellum contracti, apice sepalis utrinque dense villosulo-tomentellis lanceolato-triangularibus acuminatis ad 15 mm. longis basi circiter 6 mm. latis coronati,

pedicelli ad 18 mm. longi, plus minusve tomentelli, apice excepto non incrassati.

Yunnan boreali-occidentalis: in declivibus herbosis calcareis montium Tsang prope Tali-fu, alt. circ. 2800 m., Augusto 1914, *C. Schneider* (no. 2526; typus in Herb. Arb. Arn. et Hb. Schneider).

This variety agrees well with typical *R. Mairei* Lév. except that the leaves have 5–6 pairs of leaflets instead of only 2–4 pairs. Unfortunately the fruits of the type are still unknown. REHDER and WILSON in Sargent, Pl. Wils. **2**: 344. 1915, say that *R. Mairei* "is probably nothing more than a very hairy and small-leaved variety of *R. omeiensis* Rolfe." In my opinion, it seems much more closely related to *R. sericea* Ldl. which, however, comes very near *R. omeiensis*. The new variety may be identical with the true *R. sericea*, f. *pteracantha* Franchet in Pl. Del. 220. 1889=*R. sericea* Crépin in Bull. Soc. Roy. Bot. Belg. **25**: 9. 1886, ex parte, quoad no. 861 Delavayi, which he describes as having "folia majuscula utraque facie sericeo-tomentella," but he does not mention the number of the leaflets neither does CRÉPIN. FRANCHET'S f. *pteracantha*, however, is not identical with *R. sericea* var. *pteracantha* in Gard. Chron. III. **28**: 260. *figs. 98, 99*, 1905; and in Bot. Mag. **134**: *pl. 8218*. 1908, which is the same as *R. omeiensis* f. *pteracantha* R. and W. in Sarg., Pl. Wils. **2**: 332. 1915.

The typical *R. omeiensis* Rolfe is well characterized by its 9–13-foliolate leaves, the leaflets of which are entirely glabrous or hairy only on the midrib beneath, and by the distinctly thickened and colored (yellow or red) footstalks of the ripe fruits (see Bot. Mag. **138**: *pl. 8471*. 1912); but there are certain hairy forms with almost subsessile fruits and fewer leaflets which come very near to *R. Mairei* as well as to *R. sericea*. The type of *R. sericea* as represented by LINDLEY in his Rosac. Monogr. 105. *pl. 12*. 1820, has 7–11 leaflets which are "green and naked above, paler, with the rib and the principal veins silky beneath." We certainly need a careful study of all the forms of these 3 species which, after all, seem to be so closely connected by intermediate forms that they may have to be united under *R. sericea* which we have to study as CRÉPIN said, "au point de vue des variations que peut éprouver un type dans le revêtement de ses axes et de ses feuilles." By WILSON, FORREST, and myself many forms have been introduced into cultivation, so that we shall be able to judge the value of the different characters presented by the leaves, fruits, and branchlets by the behavior of living plants.

Rosa (Sect. CINNAMOMEAE DC.) **atroglandulosa,** n. sp.—Frutex latus erectus, ad 1.5 m. altus; rami purpurascentes glabri, aculeis satis sparsis vel in ramulis floriferis tantum infrastipularibus rectis acicularibus basi subito plus minusve dilatatis ad 8–9 mm. longis flavis muniti; turiones non visi. Folia satis crassa, chartacea, 5-foliolata, petiolo incluso 5–8 cm. longa; foliola breviter petiolulata, ovalia, ovato-elliptica, rarius obovalia, apice satis obtusa

vel breviter acuta, basi plus minusve rotundata, rarius late cuneata, lateralia inferiora minora (13–) 15–22 mm. longa, (8–) 10–15 mm. lata, superiora majora ad 3.2 cm. magna, terminalia superioribus plus minusve aequalia sed saepe paullo latiora, margine dupliciter inaequaliter glanduloso-serrata (sublobulata) dentibus majoribus mucronulatis porrectis dorso denticulas 1–3 gerentibus, superne viridia, in sicco leviter glaucescentia, laevia, glabra (interdum sparsissime glanduloso-pilosa), subtus viridescentia, dicoloria, in costa et etiam partim in nervis lateralibus utrinsecus 5–8 paullo prominulis satis rectis plus minusve pilosa et etiam ut in facie pilis glanduliferis crebris conspersa (oculo nudo quasi nigro-punctata), rete nervillorum subvisibili; petioli 2–3.5 cm. longi, ut rhachis plus minusve dense villosuli, stipitato-glandulosi et setis aculeolisque sparsis muniti; stipulae satis evolutae, ad medium adnatae, 10–13 mm. longae, auriculis latis acuminatis, margine dense glanduloso-ciliatae, ceterum ut folia pilosa et glandulifera. Flores kermesini, suaveolentes, circ. 3 cm. diametientes, solitarii vel 2–3 apice ramulorum ad 8 cm. longorum terminales; pedicelli 10–12 mm. longi, basi bracteis ovatis vel late ovatis apice subito acuminatis ad 12 mm. longis et 8–9 mm. latis dense glanduloso-ciliatis suffulti, glabri, interdum fere nudi sed plerique crebre stipitato-glandulosi; receptaculum ellipsoideo-oblongum, glabrum, nudum; sepala ovato-oblonga, extus glabra vel interiora versus marginem tomentella, intus tomentosula, eglandulosa, post florationem reflexa; alabastra ovata, obtusa; petala late obovata, emarginata, ad 2 cm. longa et 1.7 cm. lata; stamina numerosa, antheris luteis ovalibus; styli liberi, circ. 5 mm. exserti, staminibus longioribus vix breviores, villosi. Fructus ignoti.

Szechuan australis: inter urbem Yen-yüan Hsien et viculum Hun-ka, ad vias, alt. circ. 2600–2800 m., 11 Junii 1914, *C. Schneider* (no. 1484; typus in Herb. Arb. Arn. et Hb. Schneider).

This species seems to me most closely related to *R. Sweginzowii* Koehne (see figure in Fedde, Rep. Spec. **11**: 531. *fig. 3*) and R. *setipoda* Hemsl. and Wils. (see Bot. Mag. **140**: *pl. 8569*), which may easily be distinguished in having 7–9 leaflets and a different kind of wide-based prickles. *R. atroglandulosa* seems to be well marked by the frequent stipitate dark glands on the under surface of the leaves and the rather long exerted styles. I cannot refer it, even as a variety, to any of the species of this section enumerated by A. REHDER in Sarg., Pl. Wils. **2**: 339. 1915.

ROSA SOULIEANA Crép. var. **yunnanensis,** var. nov.—*R. moschata* var. *yunnanensis* Focke in Not. Bot. Gard. Edinbgh. **5**:69. 1911, nom. nud., non Crépin apud Franchet; DIELS, l.c. **7**:124. 1912 et 394. 1913, nom. nud.; *R. Soulieana* R. and W. in Sarg., Pl. Wils. **2**:314. 1915, quoad synon. Fockii et specim. Forrestii, non Crépin.—A typo recedit rhachi foliorum et costa foliolorum subtus puberula, pedicellis receptaculisque minute flavo-glanduloso-pilosis et etiam interdum pilosulis.

Szechuan australis: inter viculos Wo-lo-ho et Hu-ma-ti ad viam versus Yung-ning, alt. circ. 2800 m., 14 Junii 1914, *C. Schneider* (no. 1549; frutex ad 2.5 m. altus, patenter dense ramosus, floribus albis odoratis).

The main difference between the type and this variety seems to be the fine pubescence of the rhachis and of the midrib of the under side of the leaflets, which is not always present on the pedicels and receptacles. These are more or less covered with a short, yellowish, glandular pubescence which I find also on a cultivated specimen from VILMORIN'S fruticetum, Les Barres. VILMORIN'S plant, probably, came from the type plant in the Jardin des Plantes in Paris. The shape of the leaflets, which are described by FRANCHET as "courtes, ovales et plus ou moins arrondies, à base arrondie, obtuses- arrondies au sommet, plus rarement très brusquement mucronées," varies to a certain degree, and especially the leaves of FORREST'S no. 2370 from Lichiang, which is the type of var. *yunnanensis* of Focke, are rather acute at both ends.

VIBURNUM CYLINDRICUM Ham., var. **crassifolium,** n.var.—*Viburnum crassifolium* Rehder in Sarg., Pl. Wils. **2**:112. 1913.—A typo cum varietate ut videtur formis intermediis conjuncto differt praecipue inflorescentiis plus minusve vel satis dense pubescentibus.

Szechuan australis: in regione Yen-yüan Hsien versus occidentem inter viculos Hu-ma-ti et Wo-lo-ho, alt. circ. 2800–3000 m., 14 Junii 1914, *C. Schneider* (no. 1552; arbuscula vel arbor ad 6:0.4 m.).—Yunnan boreali-occidentalis: in dumetis inter viculos Pi-ji et Pao-to versus Yung-ning, alt. circ. 2400 m., 25 Junii 1914, *C. Schneider* (no. 3508; frutex ad 3 m. altus); in dumetis ad pedem orientalem montium niveorum prope Lichiang-fu, alt. 2900–3200 m., 29 Julii 1914, *C. Schneider* (no. 2034; frutex 2–3 metralis); eodem loco, Octobri 1914, *C. Schneider* (no. 3212).

Regarding the size of the leaves and the sparser pubescence of the inflorescences, these specimens are intermediate between the type of *V. crassifolium* Rehd., collected by A. HENRY in southern Yunnan near Mengtsze (no. 9797), and the typical *V. cylindricum* Ham. to which I refer the following numbers of my own collections: Szechuan australis: in regione Yen-yüan Hsien, in silvis prope Liu-ku, alt. 3000 m., 19 Maji 1914 (no. 1315; frutex ad 2 metralis);

prope Kua pie, ált. circ. 3000 m., 21 Maji 1914, (no. 1345; frutex vel arbor, 3–6 metralis); in regione Hua-li, in dumetis declivium ad flum. Yalung, alt. 2300 m., 30 Maji 1914 (no. 1395).

VIBURNUM CALVUM Rehd., var. **puberulum,** n. var.—A typo praecipue recedit: ramulis hornotinis et saepe annotinis biennesque et etiam inflorescentiis plus minusve puberulis.—Fructus atrocyanei, nitiduli, ovato-globosi, circ. 5 mm. longi et 4 mm. crassi, iis *V. propinqui* similes sed minus distincte apiculati; semina ovoideo-globosa, ventre leviter sulcata, albumine ruminato.

Szechuan australis: inter Hoh-si et Yen-yüan Hsien prope pagum Loma-pu, in dumetis montium, alt. circ. 2200 m., 9 Maji 1914, *C. Schneider* (no. 1146; frutex virgultus, 1.5–2 m. altus, floribus albis, fructibus atrocyaneis); in regione Kua-pie, in declivibus dumosis calcareis montium, alt. circ. 3000 m. 20 Maji 1914, *C. Schneider* (no. 1325; typus in Herb. Arn. Arb. et Herb. Schneider; frutex sempervirens, 1–1.5 m. altus, fructibus nitidis nigris).

According to the shape and the nervation of the leaves, and to the size of the inflorescence, this form is very similar to the typical *V. calvum* Rehd. from southern Yunnan, of which the fruits are not yet known. The fruits I collected are about the same as those of *V. propinquum* Hemsl. which, however, can easily be distinguished by its 3-nerved leaves.

There is another very interesting species I found in Yunnan boreali-occidentalis: inter Hoching et Teng-chuan, in silvis apertis prope Sung-queh versus angustias montium, alt. circ. 3200 m., 29 Sept. 1914 (no. 2873; frutex 3-metralis). The shape of the ovate-oblong or oblong-elliptic leaves, which measure up to 8 cm. in length and 2.8 cm. in width, is similar to those of *V. propinquum*, but they are not distinctly acuminate and not 3-nerved at the base, but have the same nervation as *V. calvum*. The fruiting corymbs are small, and bear only a few fruits, which, unfortunately, are not yet fully ripe. They are almost globose, and about 5 mm. in diameter. I cannot refer this form to any species hitherto described from China, but I believe it is very near or the same as *V. atrocyanea* (sic!) C. B. Clarke apud Hook. and Thom., Fl. Brit. Ind. 3:7. 1880 from the Mishmi Mountains in Bhutan, which I know only from the rather insufficient description of the author.

ARNOLD ARBORETUM
JAMAICA PLAIN, MASS.

BRIEFER ARTICLES

ANELSONIA, A NEW GENUS OF THE CRUCIFERAE

As GREENE remarked long ago, the so-called natural families, as Umbelliferae, Labiatae, and Cruciferae, contain relatively few natural genera, and perhaps in no group of plants are generic limitations harder to define than within some sections of the Cruciferae. Consequently, there have often been included under one generic name plants that in point of fact bear little real relationship to one another. The genus *Parrya*, as it has been treated by many recent authors, furnishes, we believe, an example of this misinterpretation of generic limitations. This genus was drawn by BROWN to include several low scapose perennials of the far North, all characterized by showy purple-red flowers and glabrous (or hirtellous with simple hairs) foliage. In 1891 GREENE (Fl. Fran. 1:253) referred to *Parrya*, *Hesperis Menziesii* Hook., a plant previously made the type of a new genus by NUTTALL (T. and G., Fl. N. Amer. 1:89. 1838) under the name *Phoenicaulis cheiranthoides* Nutt., and possessing much the same aspect as the species included by BROWN in his genus, but with the foliage whitened by a thick covering of branching and stellate hairs. A critical study and comparison of this plant with the typical members of *Parrya* has disclosed the fact, however, that technical but readily discernible differences other than the character of the pubescence exist between *Parrya* and *Phoenicaulis*. The more important of these are the lack in the latter of the conspicuous network of superimposed fibers that characterize the septum of *Parrya*, the absence of the loose epidermis so prominent about the seeds of the latter genus, the remarkably tortuous areolae, tortuous in none of the species of *Parrya*, and the nearly entire and capitate stigma. The value of characters of this type for the proper delineation of genera in the Cruciferae has been proved by PRANTL in his careful synopsis of the group in *Nat. Pflanzenfamilien*, where he retains NUTTALL'S genus.

It appears, therefore, that *Phoenicaulis* is amply distinct from *Parrya;* but, as we have already suggested, the Cruciferae as a natural family is composed of many groups, the differentiation of which has occurred within comparatively narrow limits. Such groups, possibly remotely related, may have analogous forms, and then their true relationships are apt to be lost by the systematist, particularly if he bases his classification

on vegetative characters or places too much dependence upon the often fickle "aspect." Circumstances of this nature doubtless contributed largely to the treatment by NELSON (Proc. Biol. Soc. Wash. **18**:187. 1905) of *Phoenicaulis Menziesii* as a species of *Arabis*, a disposition that was adopted later by NELSON and MACBRIDE (BOT. GAZ. **55**:374. 1913). It must be admitted that the arguments in favor of this treatment are far from weak; on the other hand, the highly technical nature of the characters to be considered in the proper definition of groups in a natural family must be borne in mind, and PRANTL has used to advantage, in "keying" *Phoenicaulis* and *Arabis*, the type of characters that furnish the best contrasts between *Parrya* and *Phoenicaulis*. The very possibility of considering *P. Menziesii* as an *Arabis* becomes, therefore, a strong argument for its retention as a genus distinct from both *Parrya* and *Arabis*.

We now come to a consideration of the plant which prompted these observations. This plant was described by GRAY (Proc. Am. Acad. **6**:520. 1866) from meager material that was far past condition as *Draba eurycarpa*, and recently has been redescribed as *Parrya Huddelliana* A. Nels. (BOT. GAZ. **54**:139. 1912). Here again we have an instance of the similarity of genera in this family, especially as regards vegetative characters. This plant would not seem at all out of place in *Draba* were aspect the only criterion we had to judge it by; and indeed the original specimen consists only of two small plants which are so mature that the seeds have all fallen. But upon examination of complete material it becomes obvious that GRAY'S species is allied to *Parrya* and *Phoenicaulis*. It is not satisfactory, however, to refer it to either of these genera. The branching pubescence, the inconspicuous white flowers, the subentire stigma, the broadly ovate-lanceolate pods, and the nearly membranous septum are some of the characters that forbid its reference to *Parrya*. The loose cellular testa about the seeds, the not at all tortuous areolae, and the inconspicuous flowers are also characters in direct contrast to those of *Phoenicaulis*. Moreover, there is the unique habit which suggests *Draba* rather than either of the genera to which it is most nearly related, but consideration of it as a *Draba* (to mention one outstanding feature) is out of the question because of the singular seed coat. Although this is suggestive of the seed coat of *Parrya*, it is of a different quality and is not winged.

Now in the proper generic allocation of these plants consideration must be given only to the value of the characters indicated for purposes of generic definition. The characters themselves are obviously definite

and distinctive; and it seems to us that there is only one possible interpretation of the problem which will conform to what experience has shown to be the logical and practical treatment of cruciferous groups. In pursuance of this view it becomes necessary to consider *Draba eurycarpa* as representing a generic type intermediate in some respects to *Parrya* and *Phoenicaulis*, and more closely related to these genera than to any others, but at the same time more distinct from either of these than they are from each other. In recognition of the notable work of AVEN NELSON, we propose that this genus bear the name *Anelsonia*.

The distinguishing characters of these related genera may be summarized as follows:

Pods ovate-lanceolate, mid-vein obscure; septum merely membranous; seeds with a loose cellular epidermis, not margined, areolae not tortuous; pubescence of branching hairs; petals white, little exceeding the pubescent sepals; stigma subentire ..... *Anelsonia*

Pods narrowly ensiform or more or less attenuate at both base and apex; mid-vein evident; seeds smooth without loose epidermis or, if this is present, more or less margined; petals usually red purple, much exceeding the glabrous sepals.

Pods more or less attenuate at both base and apex; septum bearing a conspicuous network of superimposed fibers; seeds with a loose cellular epidermis usually more or less winged, areolae not tortuous; pubescence wanting or the hairs simple; stigma lobed ..... *Parrya*

Pods narrowly ensiform; septum merely membranous; seeds smooth without loose epidermis, areolae remarkably tortuous; pubescence branching and stellate; stigma subentire ..... *Phoenicaulis*

Anelsonia, gen. nov.—Siliqua compressa ovato-lanceolata costa media inconspicue, septo membranaceo-hyalino, evanido, stigmati fere simplici. Semina 2-seriata, testa cellulosa. Sepala plus minusve pubescentia. Petala brevia.—Herbae humiles, alpinae, subcaespitosae et scapigerae, pube brevi furcata vel ramosa canae. Folia integerrima. Flores inconspicui, albi.

Anelsonia eurycarpa (Gray), comb. nov.—*Draba eurycarpa* Gray, Proc. Am. Acad. **6**:520. 1866; *Parrya Huddelliana* A. Nels. BOT. GAZ. **54**:139. 1912.

In alpine rock slides, Idaho to California.—IDAHO: Mackay, Custer County, July 31, 1911, *Nelson* and *Macbride*, no. 1466; Lost River Mountains west of Clyde, Blaine County, July 10, 1916, *Macbride* and *Payson*, no. 3128; CALIFORNIA: peak near Sonora Pass, 1863, *Brewer*, no. 1909.—J. F. MACBRIDE AND E. B. PAYSON, *University of Wyoming*.

CURRENT LITERATURE

BOOK REVIEWS

Researches in plant physiology

ATKINS[1] has written an interesting little book, the aims of which can best be expressed by quotations from the preface. "The general aim of the book is to present to senior students and investigators the results of recent work in a few of those branches of plant physiology which are at present attracting attention." "By such a presentation of portions of the science which are still in a state of rapid growth, it is hoped that further investigation will be stimulated. The choice of material by the author was, to a considerable degree, influenced by his familiarity with certain subjects of general interest, portions of which are being studied experimentally by the staff of the School of Botany, Trinity College, Dublin. Upon these, rather than upon other researches of equal or greater importance, he has felt qualified to write, on account of his first-hand knowledge of many of the methods employed. A small amount of hitherto unpublished work has also been included."

A list of the chapter headings gives an idea of the content of the book: I. The carbohydrates of the angiosperm leaf in relation to photosynthesis; II. Methods of estimating carbohydrates in plant extracts; III. The carbohydrates of the Thallophyta and Bryophyta in relation to photosynthesis; IV. The pectic substances; V. Osmotic pressure in plants; VI. The osmotic equilibrium between the cell and its surroundings; VII. The permeability of protoplasm; VIII. The permeability of organic membranes other than protoplasm; IX. The magnitudes of osmotic pressures and electrical conductivities in plants, and the factors which influence them; X. Osmotic pressure in relation to plant distribution, morphology, and cell division; XI. The functions of the wood; XII. The plant oxidases; XIII. The oxidases in relation to pigmentation, and the anthocyan pigments; XIV. The oxidases in relation to plant pathology and to technology.

As compared with a treatise on plant physiology, the book of course appears patchy, but this is an outgrowth of the aim, and is by no means an unfavorable criticism of the work. It is written in a most interesting as well as thoroughly scientific manner. On reading it one is convinced that it will attain its aim of stimulating research along many of the lines treated.—WM. CROCKER.

[1] ATKINS, W. R. G., Some recent researches in plant physiology. pp. xi+328. London: Whittaker Co. 1916.

NOTES FOR STUDENTS

Taxonomic notes.—BURT[2] has described a new species of *Pistillaria* (*P. Thaxteri*) which he records as the smallest known hymenomycete. It was collected in Connecticut, and is so minute that the "fructifications are not visible to the naked eye unless rendered so by special illumination and background." The fructifications were observed scattered on the surface of very rotten wood, "merely gregarious, not united into clusters," and as many as 115 were counted on an area 2×0.5 cm. The fungus is remarkable not only as the smallest known "toadstool," but also for its extreme simplicity of structure.

FERNALD[3] has described a new species of *Juncus* (*J. pervetus*) from Cape Cod, resembling *J. Roemerianus* in many particulars. It is stated that this new species "is one of the many remarkable species of world-wide affinities which are being discovered so frequently on the coastal area of southern New England and southeastern British America."

GATES[4] has had occasion to investigate *Trillium* in connection with his work in genetics, and has been impressed with the great variability of the genus in certain organs. In attempting to delimit the species, he recognizes 31 species with 9 varieties. *T. venosum* is described as a new species from Idaho, and new varieties are described in *T. luteum*, *T. lanceolatum*, *T. grandiflorum*, and *T. ovatum*. The published records of variation in the genus are brought together, and their number is remarkable. The author suggests that the genus *Paris* has been derived from the *T. erectum* group, and that *Medeola* has also come from *Trillium*.

GREENMAN,[5] in continuing his studies of *Senecio*, has presented § LOBATI, comprising 16 species, 4 of which are described as new.

HOWE and HOYT,[6] in studying a small collection of algae obtained through dredging operations on August 11, 1914, in water on a reef about 23 miles off shore from Beaufort, discovered 7 new species belonging to the following genera: *Microchaete*, *Derbesia*, *Phaestroma*, *Erythrocladia* (2), *Acrochaetium* (2). The collection also contained 2 species previously known from Europe only, namely, *Streblonema solitarium* and *Elachristea stellulata*.

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[2] BURT, E. A., *Pistillaria* (subg. *Pistillina*) *Thaxteri* Burt. n.sp. Ann. Mo. Bot. Gard. **3**:403–406. 1916.

[3] FERNALD, M. L., A new *Juncus* from Cape Cod. Rhodora **19**:17–20. 1917.

[4] GATES, R. R., A systematic study of the North American genus *Trillium*, its variability, and its relation to *Paris* and *Medeola*. Ann. Mo. Bot. Gard. **4**:43–92. *pls. 6–8*. 1917.

[5] GREENMAN, J. M., Monograph of the North and Central American species of the genus *Senecio*. Part II. Ann. Mo. Bot. Gard. **4**:15–36. *pl. 4*. 1917.

[6] HOWE, M. A., and HOYT, W. D., Notes on some marine algae from the vicinity of Beaufort, North Carolina. Mem. N.Y. Bot. Gard. **6**:105–123. *pls. 11–15*. 1916.

MACKENZIE,[7] in continuation of his studies of *Carex*, has presented the "Californian representatives of the OVALES." The list includes 25 species, 15 of which are described as new.

ROBINSON[8] has published a detailed monograph of the American genus *Brickellia*. The need of it, the author remarks, "presents no unusual condition among the larger genera of the Compositae." The 91 species, 11 of which are new, are grouped in 9 sections. The systematic presentation is preceded by a full discussion of the diagnostic value of the characters used.

RYDBERG,[9] in continuation of his studies of the Rosaceae, has investigated the species of *Rosa* occurring in California and Nevada. He recognizes 34 species, 12 of which are described as new.

TIDESTROM[10] has described a new *Allium* (*A. platyphyllum*) from the Wallowa National Forest of Oregon.—J. M. C.

Effect of carbon dioxide on respiration.—KIDD[11] has studied the effect of various concentrations of carbon dioxide on the rate of anaerobic and aerobic respiration of seeds of peas with testas both intact and removed. The work is marked by brilliancy of design, and in the main of execution. In concentrations of CO_2 ranging from 0 to 50 per cent, the depressing effect on anaerobic respiration is proportional to the square root of the concentration. As the concentration rises above 50 per cent, the depressing effect falls more and more behind the square root of the concentration. Carbon dioxide also depresses aerobic respiration when measured either by oxygen consumption or CO_2 production. In the latter case the concentration effect is similar to that in anaerobic respiration. When oxygen is deficient, CO_2 has no depressing effect upon the oxidation phase. It is assumed that the primary anaerobic phase is then progressing fast enough not to limit the secondary aerobic phase of respiration, and that it is only the anaerobic phase that CO_2 depresses. Only the so-called floating respiration of BLACKMAN (respiration of storage carbohydrates, fats, and proteins) and not protoplasmic respiration (respiration still occurring in starving tissue) is thus depressed. The work throws considerable light upon the mechanism of respiration.

In work of this sort one should be sure that the cultures are sterile and that the anaerobic CO_2 production is that of the seeds and not of organisms growing

[7] MACKENZIE, K. K., Notes on *Carex*. XI. Bull. Torr. Bot. Club **43**:601–620. 1916.

[8] ROBINSON, B. L., A monograph of the genus *Brickellia*. Memoirs Gray Herb. I. pp. 151. *figs.* 95. 1917.

[9] RYDBERG, PER AXEL, Notes on Rosaceae. XI. Bull. Torr. Bot. Club **44**:65–84. 1917.

[10] TIDESTROM, IVAR, *Allium platyphyllum*, sp. nov. Torreya **16**:242. 1916.

[11] KIDD, FRANKLIN, The controlling influence of carbon dioxide. Part III. The retarding effect of carbon dioxide on respiration. Proc. Roy. Soc. B **89**:136–156. 1916.

on them. While the author speaks of sterilizing the seeds with bromine, he says nothing about making cultures to assure that they are sterile. Many authors find it difficult to sterilize seeds without killing them. This is specially true of those with open micropyles. From the first two papers of the series, KIDD reemphasizes his conception that the dormancy of "moist seeds" is due to the anesthetic action of carbon dioxide which is held in by seed coats. If this be the cause of dormancy in any imbibed seeds, it is limited in its application. It does not apply to seeds which have a rest period during which the embryo is developing; to seeds like *Alisma* and *Amaranthus*, in which the swelling contents do not have sufficient pressure to break the coats; or to seeds like *Crataegus*, in which the embryos are dormant when naked.[12] He has by no means proved that this holds even for forms forced by increased oxygen pressure (*Xanthium* and others). His conception implies that the coats of these seeds are very slightly permeable to CO_2. In the elementary course in plant physiology in Hull Botanical Laboratory, we used for years various seed coats and the epidermis of various leaves to show that moist plant membranes are relatively very permeable to CO_2 in contrast to oxygen and nitrogen. KIDD's assumption concerning CO_2 and dormancy of seeds, therefore, even under limited application, cannot be considered more than an hypothesis without a study of the permeability character of the seed coats to CO_2 and other gases.—WM. CROCKER.

Vegetation of South Africa.—In a region where climate differs strikingly over areas of comparatively small size, there is usually a corresponding diversity of vegetation. Apparently such diversity is displayed to a remarkable degree in South Africa, as seen in the recent studies by BEWS. In his earlier papers, reviewed in this journal,[13] a general account of the vegetation of Natal was given and a more detailed study of some areas within its limits. In his latest article BEWS[14] has sketched the vegetation of a wider area and has begun the study of its succession. The condition of Table Mountain is perhaps typical of the broader area, showing a precipitation upon the western side of 60–75 cm. annually and resulting sclerophyllous scrub communities, while upon the eastern slopes the precipitation is doubled and a rather mesophytic forest results. The former characterizes the southwestern region of the Cape and passes from a fell field with an open stand of grasses, Crassulaceae, Compositae, and dwarf Ericaceae, to a heath dominated by *Blaeria ericoides*, a South African heather, or by a variety of dwarf shrubs in which species of *Protea*, *Erica*, *Rhus*, *Polygala*, and many less familiar genera, along with many bulbous monocotyledons, are conspicuous.

[12] CROCKER, WM., Mechanics of dormancy in seeds. Amer. Jour. Bot. 3:99–120. 1916.

[13] BOT. GAZ. **59**:68–69. 1915.

[14] BEWS, J. W., An account of the chief types of vegetation in South Africa, with notes on the plant succession. Jour. Ecol. **4**:129–158. 1916.

A related formation of higher growth is the "macchia," which in some regions succeeds the heath. In it the Ericaceae become less abundant with the increase in size of the woody plants, but such genera as *Protea* and *Rhus* have more representatives, while associated with them are species of *Olea*, *Celastrus*, *Leucadendron*, and many other genera.

On the southeastern slopes facing the Indian Ocean, the greater summer rainfall produces a mesophytic forest, often dominated by *Podocarpus* or by *Rhus longifolia* and *Albizzia fastigiata*.

Grassland, much of it interspersed with scattered trees or shrubs, known variously as *Acacia* veld, *Protea* veld, or bush veld, extends through much of Natal, Transvaal, and Rhodesia. The tree veld becomes increasingly arid toward the west and includes much of Great Namaqualand and Damaraland. Northward the vegetation becomes more luxuriant, passing to rich grasslands with large trees of the baobab, *Adansonia digitata*, and of *Copaifera mopane* in Angola.

In dry river valleys of Natal and elsewhere, a rather rich scrub formation is found, characterized by tree species of *Euphorbia*, *Aloe*, and *Mesembryanthemum*, and succulent or semisucculent lianas, in addition to the more woody shrubs and trees.

Finally, there is the Karroo with a rainfall of 8–35 cm., and a vegetation of dwarf shrubs, leaf and stem succulents, bulbous plants, a few grasses, and some annuals. BEWS is inclined to class this with the grassland rather than with the desert. He finds, in fact, that there is little true desert in South Africa, the so-called "Kalahari desert" also being more truly veld or grassland.—GEO. D. FULLER.

Effect of fungi on fruits.—HAWKINS[15] has studied the effect of the brown-rot fungus upon the chemical composition of the peach, and CULPEPPER, FOSTER, and CALDWELL[16] have made a similar but more complete study of the changes in the apple during decay by the black-rot fungus. *Sclerotinia cinerea* increases acidity of the peach during decay. Among the carbohydrates the pentosans are not attacked; the alcohol-insoluble portion which reduces Fehling's solution after being hydrolyzed with dilute hydrochloric acid is slightly decreased; and the total sugar content is much decreased. The sucrose practically disappears during decay; its inversion occurs more rapidly than the resulting reducing sugars are used by the fungus. As a result, the percentage of reducing sugars in the decaying fruit is greater than in the sound fruit, although the total sugar content is less.

[15] HAWKINS, LON A., Some effects of the brown-rot fungus upon the composition of the peach. Amer. Jour. Bot. **2**:71–81. 1915.

[16] CULPEPPER, CHARLES W., FOSTER, ARTHUR C., and CALDWELL, JOSEPH S., Some effects of the black-rot fungus, *Sphaeropsis malorum*, upon the chemical composition of the apple. Jour. Agr. Research. **7**:17–40. 1916.

In the case of the apple, the lipoids are attacked and decreased, but later a large amount of lipoid is constructed in the fungus itself. Non-protein nitrogen of the apple is converted into protein nitrogen of the parasite, decrease of the former paralleling increase of the latter; but some nitrogen loss results from complete decomposition of nitrogenous compounds with liberation of ammonia. The lipoid phosphorus and protein phosphorus of the apple are first broken down into soluble form, and then reconstructed into protein phosphorus within the parasite. The sugars decrease rapidly as the disease proceeds. The disaccharides are used much less rapidly and completely than the monosaccharides. The starch content remains unchanged. Acidity decreases, for the malic acid of the apple is decomposed without the formation of any other acids by the organism, and a large amount of alcohol is formed from soluble carbohydrates. The authors claim a fairly complete statement of the chemical differences between sound and black-rot diseased apples.—CHARLES A. SHULL.

Tropical vegetation.—In a botanical travelogue, GLEASON[17] has described in a semi-popular way so many phases of vegetation as to make his series of articles an excellent one for visualizing the diversity and luxuriance of tropical forests. Japan with its intensive cultivation of all available land has so little natural vegetation that it becomes insignificant compared with the Philippines. Here the reader is guided through a forest remarkable for luxuriance and rapidity of growth, and made acquainted with many lianas, epiphytes, and strangling figs or "baletes," without losing sight of the stratification of tree growth. Interruptions of the forest growth made by the natives in their attempts at agriculture are seen in the rapid reforestration of the "parangs," or when fire has intervened in the grassy "cogons." Among other matters of botanical interest is the action of volcanoes, like that of Taal, in destroying vegetation and thus furnishing a splendid field for the study of plant reestablishment and succession.

At Java the Botanic Garden of Buitenzorg with its 16,000 species of plants and the less known but not less interesting economic garden were visited. In the latter collections of such different rubber plants as *Ficus*, *Hevea*, *Castilloa*, and *Manihot* growing side by side seem to abound. The mountain garden at Tjibodas was visited also and the beauties and advantages of these collections of tropical plants are pointed out. A similar visit to the garden at Peradeniya and excursions to examine various types of vegetation upon the island of Ceylon complete the tour.—GEO. D. FULLER.

Potamogeton.—HAGSTRÖM[18] has published an elaborate monograph on *Potamogeton*, in which the classification is based largely upon anatomical

[17] GLEASON, H. A., Botanical sketches from the Asiatic tropics. I. Japan; II. Philippines; III. Java; IV. Ceylon. Torreya **15**:93–101, 117–133, 139–153, 161–175, 187–202, 233–244. 1915; **16**:1–17, 33–45. 1916.

[18] HAGSTRÖM, J. O., Critical researches on the Potamogetons. Kgl. Svensk. Vetensk. Handl. **55**:no. 5. pp. 281. *figs. 119*. 1916.

features. The stele presents 6 "stages" of development, differing in the number and arrangement of the bundles; while 5 kinds of endodermis are recognized. An interesting series of facts is recorded in reference to the "adaptation of some leaves for a double life," and also their "adaptation for different levels of water." Another adaptation explained is the "arrangements in stems and leaves for the purpose of resisting the impetus of the waves and the current of water," 6 kinds of stem structure being recognized. All of these anatomical variations are not merely observed, but are arranged in evolutionary sequence. Numerous hybrids are recognized by means of the new characters used, as well as by sterile pollen grains and "deformed stigmata." In general, hybrids are very sterile, but sometimes sterility was found to occur also in "genuine species." The 138 species, 37 of which are described as new, and the 62 recognized hybrids are grouped in 26 sections. When it is remembered that *Potamogeton* has been credited heretofore with approximately 65 species, this increase to 200 species and hybrids indicates that it is a much more complex assemblage of forms than has been supposed. In general, the species and hybrids are described in great detail, not only including the ordinary taxonomic characters, but also their anatomy and "biology." In short, the monograph treats of the taxonomy, morphology, anatomy, and ecology of *Potamogeton*.—J. M. C.

Pennsylvania trees.—One of the best of the recent tree manuals issued by various states comes from Pennsylvania.[19] It consists of two parts, the first devoted to an elementary discussion of the principles of forestry, the second consisting of an illustrated manual of the trees of the state. Among the topics treated in an interesting manner are the character of forest stands, their natural and artificial reproduction, the form and structure of trees, including a large number of photographic studies of bark, types and structure of twigs, buds, leaves, flowers, and fruit, and the structure of the wood. In the second part the keys and descriptions appear to be adequate and the illustrations decidedly superior to those usually seen. An entire page is devoted to each species, and the drawings include, in addition to the usual leaves and fruit, careful sketches of the flowers, buds, and leaf scars. The term "tree" is so broadly interpreted as to include such woody plants as *Rhus copallina*, *Acer spicatum*, and *Kalmia latifolia*.—GEO. D. FULLER.

Addisonia.—The fourth number of this finely illustrated journal contains colored plates and popular descriptions of *Sedum diversifolium*, *S. humifusum*, *Catasetum Scurra*, *Chionodoxa Luciliae gigantea*, *Agave subsimplex*, *Dasylephana Porphyrio*, *Cymophyllus Fraseri*, *Rhus hirta dissecta*, *Opuntia vulgaris*, *Tillandsia sublaxa*, and *Echeveria australis*.—J. M. C.

[19] ILLICK, J. S., Pennsylvania trees. Pa. Dept. Forestry Bull. 11. pp. 232. *pls.* 129. *figs.* 109. 1915.